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NATIONAL DAM INSPECTION PROGRAM. EBENEZER DAM (NDI NUMBER PA-00--ETC(U)
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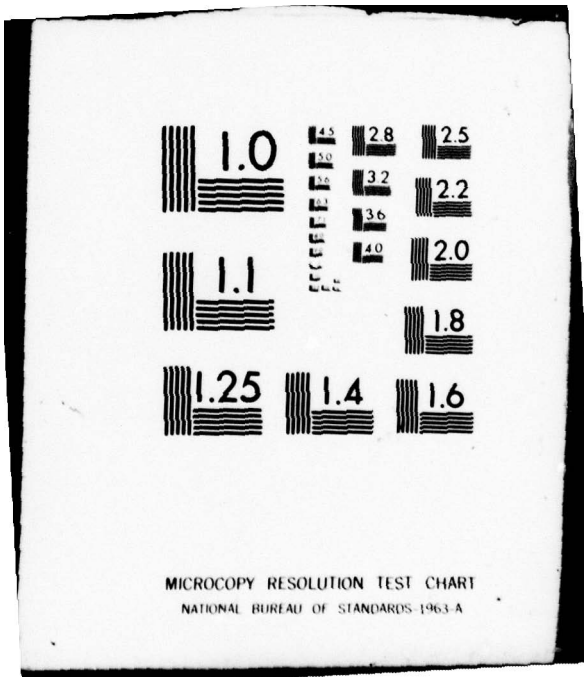
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SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the Ebenezer Dam is poor. The upstream slope at the waterline is steep over the length that is not protected by a wall. The downstream slope is saturated over large areas and has a large amount of brush and small tree growth.

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(11) May 79

(6) National Dam Inspection Program. Ebenezer Dam (NDI Number PA-00599, DER Number 38-8), Susquehanna River Basin, Lebanon County, Pennsylvania. Phase I Inspection Report.

PREFACE

(15) DACW31-79-C-0012

This report has been prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evoluntionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITIONS AND RECOMMENDATIONS

Name of Dam: EBENEZER DAM, NDI NO. PA-00599

State & State No: PENNSYLVANIA, 38-8

County: LEBANON

Stream: CLARKS RUN, TRIBUTARY TO SWATARA CREEK

Date of Inspection: April 6, 1979

Based upon the visual inspection, past performance and the available engineering data, the dam and its appurtenant structures appear to be in poor condition.

In accordance with the Corps of Engineers' evaluation guidelines, the combination of storage and spillway capacity is capable of passing only 19 percent of the Probable Maximum Flood (PMF) and the spillway is, therefore, deemed to be seriously inadequate. The dam in its present condition is considered to be unsafe, non-emergency.

The following recommendations are made for action by the owner:

1. That a detailed engineering investigation be conducted by a professional engineer, experienced in the design and construction of dams, to determine the source and cause of the observed saturated condition on the downstream slope, including appropriate instrumentation and to assess the influence of this condition on the stability of the structure, and to determine what measures should be taken to improve the capacity of the spillway.

2. That a positive method of closure of the upstream end of the outlet pipe be established.

3. That the downstream blowoff valve be made operable and maintained on a regular basis and emergency drawdown procedures be established.

4. That brush be removed from the downstream slope and a procedure be developed and implemented to provide regular maintenance of the embankment slopes.

5. That the forebay and spillway chute walls be repaired.

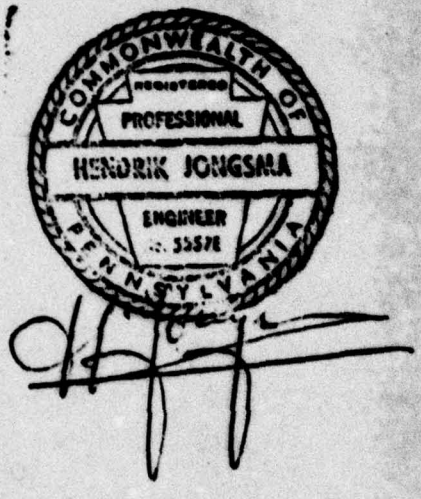
6. That the upstream slope be protected with riprap.

7. That a formal surveillance and downstream warning system be developed by the owner to be used during periods of heavy or prolonged precipitation.

SUBMITTED BY:

BERGER ASSOCIATES, INC.
HARRISBURG, PENNSYLVANIA

DATE: May 29, 1979



APPROVED BY:

G. K. WITHERS
Colonel, Corps of Engineers
District Engineer

DATE 27 Jun 79

OVERVIEW

EBENEZER DAM

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PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

EBENEZER DAM

NDI-ID NO. PA-00599
DER-ID NO. 38-8

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

A. Authority

The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the corps of Engineers, to initiate a program of inspections of dams throughout the United States.

B. Purpose

The purpose is to determine if the dam constitutes a hazard to human life and property.

1.2 DESCRIPTION OF PROJECT

A. Dam and Appurtenances

NOTE: Due to lack of information on elevations of this dam, the spillway weir elevation was set at elevation 543.0 for this report. This was obtained by interpretation from the U.S.G.S. Lebanon Quadrangle map which identifies this dam as Lights Dam.

ABSTRACT

Ebenezer Dam is an earthfill structure, constructed in about 1820 by the Union Canal Company as a feeder for their canal. The embankment length is about 230 feet with a maximum height of 25 feet. The spillway chute, located in the right abutment, makes a sharp drop and bend about 55 feet from the centerline dam and then parallels the embankment abutment and toe and joins the original streambed near the left abutment of the embankment. An abandoned gate structure at the upstream toe of the dam provides an uncontrolled upstream discharge through a 20-inch cast iron pipe. This pipe is closed off at the downstream end by an 12-inch inoperable valve in a small stone headwall structure. (Refer to Appendix A, Plate A-I).

ABSTRACT

B. Location: North Lebanon Township, Lebanon County
U.S.G.S. Quadrangle, Lebanon, PA
Latitude 40°-21.4', Longitude 76°-27.3'
(Appendix F, Plates I and II)

C. Size Classification: Small (25 feet high, 166 acre-feet)

D. Hazard Classification: High (Section 3.1.E)

E. Ownership: Lima Enterprises, Inc.
Mr. John Matarazzi
2100 Water Street
Lebanon, PA 17042

f. Purpose of Dam: Recreation

G. Design and Construction History

The dam, constructed around 1820 by the Union Canal Company, was first inspected in February, 1915 by the Water Supply Commission of Pennsylvania, predecessor of the Pennsylvania Department of Environmental Resources (PennDER). A report written by the inspector stated that no information was available regarding the design and construction of the dam. There are no records indicating that changes have been made to the original facilities, except maintenance work and the raising of the embankment by several feet.

Ownership of the dam has been transferred many times. The Union Canal Company was acquired by the Philadelphia and Reading Railroad Company. When traffic in the Canal diminished, the dam was acquired by the Lebanon Furnace Company in 1892. This company became a part of the Pennsylvania Steel Company. The Lebanon Water Company, a subsidiary of this steel company operated the facilities until ownership was transferred in 1919 to the Bethlehem Steel Company. Around 1930 the reservoir was acquired by the Lebanon Lions Club for use as a recreational facility. In the forties ownership was transferred to a Mr. Perry Sanger and in 1950 to Mr. Richard Snavely, who sold the property to the Lions Club in 1962. The present owner, Lima Enterprises, Inc., obtained the property in 1971.

H. Normal Operating Procedures

The reservoir created by the dam is used for recreation only. All inflow is either stored below spillway weir elevation or discharged over the spillway. The blowoff pipe has not been operated for many years. A private beach is located adjacent to the spillway and a public beach is located across the reservoir from the dam.

1.3 PERTINENT DATA

A.	**Drainage Area** (square miles)	
	Computed for this Report Review engineer used .6 square miles in 1915.	.5
B.	**Discharge at Dam Site** (cubic feet per second) See Appendix C for calculations	
	Maximum known flood at dam site June, 1972 (Agnes) Inflow estimated on basis of records for USGS gage on Beck Creek near Cleona	570
	Warm water outlet	None
	Outlet pipes at low pool elevation 525	6
	Outlet pipes at normal pool elevation 543 (if 12-inch is operable)	17
	Spillway capacity at maximum pool elevation 546.6 (low point of embankment)	220
C.	**Elevation** (feet above mean sea level)	
	Top of dam (top of spillway abutments)	547.6
	Low point in embankment	546.6
	Normal pool (estimated from U.S.G.S.)	543.0
	Upstream portal invert of outlet pipes about	523
	Downstream portal invert of outlet pipes about	522
	Streambed at centerline of dam	521
D.	**Reservoir** (miles)	
	Length of maximum pool	.4
	Length of normal pool	.4
E.	**Storage** (acre-feet)	
	Spillway crest (Elev. 543)	123
	Top of dam (Elev. 546.6)	166

F. Reservoir Surface (acres)

Top of dam (Elev. 546.6)	15
Spillway crest (Elev. 543)	10.1

G. Dam

No construction data available. See Appendix A, Plates A-I, A-II and A-III.

Type: Earthfill.

Length: 230 feet.

Height: 25 feet.

Top Width: 13 feet - varies at abutments.

Side Slope: Upstream - over half of the length of the dam there is a masonry wall to one foot below normal pool. The other half varies, but is steep above normal pool level. Below normal pool probably 2H to 1V.

Downstream - 1.75H to 1V.

Zoning: Unknown.

Impervious Core: Unknown.

Cutoff: None reported.

Grout Curtain: Unknown (not practiced in 1820).

H. Outlet Conduit

A 20-inch cast iron pipe, uncontrolled at upstream end and a 12-inch valve at downstream end.

I. Spillway

Type: Uncontrolled broadcrested weir with chute.

Length: 12 feet at crest with vertical abutment walls.

Crest Elevation: 543.0.

j. Regulating Outlet

One vertical valve, inoperable.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

A. Hydrology and Hydraulics

The files of PennDER did not contain original design information on this 160 year old dam. A report, written in 1915 by the Water Supply Commission, states that the spillway crest at the time of inspection was 2.4 feet below the lowest point of the embankment and that the spillway discharge capacity was only 100 cfs based on a 12.4 feet wide spillway. This was not considered sufficient for the expected inflow, but it was not considered serious in view of the storage capacity of the reservoir.

An inspection report in the files of PennDER dated April 8, 1942, calculates the capacity as 300 cfs based on a spillway depth of 4.67 feet. The dam crest had been raised prior to the 1942 inspection.

B. Embankment

Design criteria for the embankment were not available for review. The only available description of the dam is a report by the Water Supply Commission, dated February 25, 1915. The report states that the crest of the dam had a width of 9 feet, the downstream slope was 1.75H to 1V over three quarters of its height (the lower part of the downstream slope was 2.5H to 1V) and the upstream slope was 2H to 1V. The embankment material consisted of clay, containing about 50 percent of fine decomposed shale. The foundation was a firm clay.

C. Appurtenant Structures

There was no design data in the files of PennDER. The previously mentioned report states that the 20-inch C.I.P. was about 24-feet below the top of the dam. The upstream end of the pipe was provided with an iron shear gate, enclosed in a masonry bay, which extended to the top of the dam elevation. On the top of this masonry was the mechanism to operate the gate. The downstream end of the pipe ended 16 feet beyond the toe in a substantial masonry headwall. It is not known if the pipe was encased or supported over its full length. Photographs taken in 1919 indicate no valve control at the downstream end. Photographs dated 1929, show a downstream gate valve and the presence of the upstream shear gate.

The spillway was placed in a cut at the right end of the embankment. The bottom consisted of large flat stones laid in cement mortar. The walls were 2 feet thick.

2.2 CONSTRUCTION

Information about the actual construction of these facilites is apparently nonexistant.

2.3 OPERATION

There are no formal records of operation. As described in Section 1.2.G, the dam and reservoir has had a large number of owners over the years of its existence. The original use was for supply of water to the Union Canal by releasing water through the upstream shear gate as supply demanded. Later on, the reservoir was used as a supply of industrial water for a steel plant and since 1920 the reservoir has been used for recreation only.

The inspection reports in PennDER files indicate that leakage and maintenance have been long ongoing problems. Leakage was not reported in the February, 1915 report, but a report dated July, 1915 states that considerable leakage occurred along the entire toe of the embankment. Leakage appeared to be dangerous in character and amount and the installation of a weir was requested. In August, 1915, a weir was installed, located about 50 feet downstream of the pipe outlet and it was reported that leakage water appeared muddy and cloudy. Weir readings of this period are reproduced in Appendix B. A further sequence of important summaries of the inspection reports are also in Appendix B.

A letter dated August 19, 1919, from Bethlehem Steel Company, indicates that one of the leaks was not through the embankment, but through the shale on the south side of the dam, about 100 feet away from the dam.

2.4 EVALUATION

A. Availability

The only existing engineering data consisted of inspection reports by PennDER or its predecessors and are contained in the files of PennDER.

B. Adequacy

The available data was not sufficient to review the engineering criteria used for these facilities nor to make a detailed review of the design of the embankment.

C. Operating Records

Formal operating records have not been maintained. Inspection reports and weir readings indicate that a rather serious leakage has existed since at least 1915. It was reported several times that a hole appeared on the upstream slope and on the downstream slope adjacent to the pipe outlet.

D. Post Construction Changes

There is no indication in the available files that changes have been made to the original construction with the exception that the upstream shear gate on the outlet pipe was replaced by a downstream valve. Erosion and settlement required additional fill on top of the dam on several occasions.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General

The general appearance of the Ebenezer Dam is poor. The upstream slope at the waterline is steep over the length that is not protected by a wall. The downstream slope is saturated over large areas and has a large amount of brush and small tree growth.

The visual check list is presented in Appendix A, which also contains a profile of the dam and typical sections, as surveyed during the inspection. Photographs taken during the inspection are included in Appendix E.

B. Embankment

The crest of the dam has an uneven profile, with its lowest point one foot below the top of the spillway wall. The width varies, but is adequate. The upstream slope has a masonry wall protection from about one foot below normal pool to the top of the crest over about half its length (Appendix A, Plate A-II). The wall is tilting slightly outward. The rest of the upstream slope is unprotected and rather steep to one foot below normal pool due to wave erosion. A few large bushes are on this slope.

The downstream slope is in poor condition and has a large amount of weed, brush and sappling growth. Leakage through the embankment is evident along the entire slope. In several small areas the leakage is apparently limited to small horizontal layers within the embankment, showing no increase in seepage on the lower embankment face. In most cases, however, the "wet" zone shows marked increases in the water content in the lower limits of the embankment, becoming saturated at the toe, and immediately downstream. The saturated clay made a slippery surface to walk on and footprints would collect water. Undetermined amounts of leakage water were present at the left abutment and along the left spillway wall. The toe of the embankment is adjacent to the downstream discharge channel, preventing an evaluation of the amount of water seeping through the embankment.

A slough scar is located near the center of the embankment, covering a plan area of about 10 feet by 20 feet (see Plate A-I and A-III, Appendix A). A large tree is located near the left abutment and should be removed. Local residents stated that the dam was slightly overtopped during the tropical storm Agnes in 1972. The left end of the

embankment abuts against a roadway. A small curved section provides an overflow toward the roadway and during high pool levels, water will flow over this section and discharge along the roadway berm.

Some kind of a diving board is anchored in the top of the embankment. Although this is an undesired item, the crest is wide at this location and no surface cracks were noticed.

C. Appurtenant Structures

The broadcrested spillway is cut in original ground at the right abutment of the dam. The concrete block walls in the forebay area have fallen over into the approach opening (see photographs). The spillway channel is paved with concrete over the original flat stones. This channel makes a sharp bend to the left and then parallels the toe of the fill. The right wall of the chute, at this bend, is too low and has failed. Water flows over this wall and has caused considerable erosion in the soft shale behind the wall and failure of the wall over most of its length, beyond the bend.

The outlet consists of a 20-inch cast iron pipe starting at a gate structure at the upstream end. The gate in this structure has been removed. The downstream end of this pipe has a 12-inch valve, which has not been operated for many years (Refer to Appendix A, Plate A-I).

D. Reservoir Area

The banks of the reservoir are quite flat and grassed, except for two sandy beaches; one private and one public. Two beach houses and diving boards are present. The drainage area is mostly agriculture with some housing development.

E. Downstream Channel

The spillway discharge channel parallels the toe of the dam embankment and joins the original streambed near the left abutment, where the creek makes a sharp 90° bend to the right. About 250 feet below the dam, the creek flows through two 18-inch concrete pipes under Route 72 and then for several miles through farm lands. Several farms and houses are located within the flood plain and it is expected that the loss of life would increase significantly if the dam would fail due to overtopping. The hazard category is, therefore, considered to be "High".

3.2 EVALUATION

The overall evaluation of the facilities indicates that the dam is in poor condition. The saturated downstream slope, the deteriorated forebay walls and spillway chute walls and the inoperable condition of the blowoff valve require immediate attention.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

The Ebenezer Dam is privately owned by Lima Enterprises, Inc., a company owned solely by Mr. John Matarazzi. The reservoir is used for recreation, fishing, and swimming, and has a swim beach and a beach house. Formal operating procedures of the facilities have not been established.

4.2 MAINTENANCE OF DAM

Although some cutting of brush and trees on the downstream slope has occurred, a regularly scheduled maintenance program of the slope should be initiated. The top of the dam is well maintained, but the upstream slope appears to be in need of protection against erosion.

4.3 MAINTENANCE OF OPERATING FACILITIES

The downstream valve on the 12-inch drawdown pipe has not been maintained and is inoperable. The spillway forebay walls and discharge channel walls are in need of repair or replacement.

4.4 WARNING SYSTEM

A formal surveillance and downstream warning system does not exist at the present time.

4.5 EVALUATION

Operational procedures do not exist at the present time. It is recommended that a regular maintenance schedule for the embankment and operating facilities be developed. A formal surveillance and downstream warning system should be established to be used during periods of heavy or prolonged precipitation.

SECTION 5 - HYDROLOGY/HYDRAULICS

5.1 EVALUATION OF FEATURES

A. Design Data

The hydrologic and hydraulic analysis available from PennDER for Ebenezer Dam was not very extensive. No area-capacity curve, frequency curve, unit hydrograph, design storm, design flood hydrograph, nor flood routings were available.

A report prepared in 1915 listed the distance from the spillway crest to the top of the dam as 2.4 feet, and reported the spillway capacity as 100 cfs.

B. Experience Data

There were no records available for past floods, but a local resident recalled that the flood of June 22, 1972, raised the pool level to about the top of the embankment. He also recalled that the embankment along the roadway was cut to allow water to be diverted down the road and prevent overtopping. The size of this excavation is unknown.

C. Visual Observations

The hydraulic features of this dam were found to be in poor condition. The spillway approach and outlet channel need repairs and the drawdown or blowoff need attention in order to be made operable.

D. Overtopping Potential

Ebenezer Dam has a total storage capacity of 166 acre-feet and an overall height of 25 feet above streambed. These dimensions indicate a size classification of "Small". The hazard classification is "High" (see Section 3.1.E).

The recommended Spillway Design Flood (SDF) for a dam having the above classifications is one-half the Probable Maximum Flood (PMF) to the PMF. For this dam, the PMF peak inflow is 1,560 cfs (see Appendix C for HEC-1 inflow computations).

Comparison of the estimated PMF peak inflow of 1,560 cfs with the estimated spillway discharge capacity of 230 cfs, using the low point in the embankment, indicates that a potential for overtopping of the Ebenezer Dam exists.

An estimate of the storage effect of the reservoir and routing of the computed inflow hydrograph through the reservoir shows that this dam

does not have the necessary storage available to pass the PMF without overtopping. The spillway-reservoir system can pass a flood event equal to 19% of a PMF.

If the low area in the top of the dam would be raised to the level of the top of the spillway walls (Elevation 547.6) the spillway-reservoir system will still only be able to pass a flood event equal to 26% of a PMF.

E. Dam Break Evaluation

The calculations to determine the behavior of the dam in the event of an overtopping and a resulting breaching of the embankment indicates that there will be a substantial increase in water levels downstream from the dam.

Several houses and a state highway are located about 500 feet downstream from the dam. On the basis of the results of a dam break analysis, using the U.S. Army Corps of Engineers HEC-1 program, the water surface elevation in the vicinity of the houses would be about 524.2 when the water surface in the reservoir above the dam is just at the crest elevation (low point) of the embankment (no overtopping). (Refer to Table 1, Appendix C). It is expected that 25 percent of a PMF would cause the water level in the lake to reach an elevation that would result in a breach (0.5 foot above crest elevation). Just prior to failure by the 25 percent PMF flow, the water surface elevation 500 feet downstream would be about 524.7. The increase due to overtopping under no failure condition would be approximately (524.7 - 524.2) 0.5 feet. While more property would be exposed to flooding, the increase to the danger of loss of life is not considered significant. With failure, however, the breaching analysis indicates a rise of about 7.4 feet above the flow level just prior to breach when considering a 15 minute time to complete the breach and a 2.6 feet rise above flow level just prior to breach when considering a 2 hour time to complete the breach. The increase in hazard to loss of life and property damage is reflected not only in the increase in depth of water of 7.4 feet in the 15 minute breach and 2.6 feet in the 2 hour breach, but more significantly in the shorter time to reach the peak. Less time would be available to respond to the flooding under the breach conditions.

Being an earth embankment, it is judged that a breach is likely to develop when the depth of flow over the crest is 0.5 foot or greater and that the breach would be completed between the 15 minute and the 2 hour period. The numerical difference of water levels is 4.8 feet. The property damage would be similar with either time. Again, however, the time factor is most significant regarding loss of life. Calculations indicate that the water depth will increase at a rate of 7.4 feet in 15 minutes under the 15 minute breach condition.

On the basis of these calculations, it is concluded that the hazard to loss of life and property damage is significantly increased when the dam is overtopped as compared to the condition just prior to overtopping.

Refer to Table 1, Appendix C, for comparison of flood water levels.

F. Spillway Adequacy

The small size category and high hazard category, in accordance with the Corps of Engineers criteria and guidelines, indicates that the Spillway Design Flood (SDF) for this dam should be one-half the Probable Maximum Flood (PMF) to the full PMF.

The calculations show that the spillway discharge capacity and reservoir storage capacity combine to handle 19% of the (PMF) without overtopping the dam. These calculations have considered the existing low point along the embankment crest.

Being an earth embankment dam, it is judged that a breach is likely to develop when the depth of flow over the crest is 0.5 foot or greater than the flood of record. These studies also indicate that the depth of flow over the crest of the embankment due to one-half PMF is more than the 0.5 foot criteria. On the basis of this information, it is judged that a one-half PMF will cause overtopping of the embankment and will most likely cause a breach. Therefore, the spillway capacity is considered to be seriously inadequate.

The hydrologic analysis for this investigation was based upon existing conditions of the watershed. The effects of future development were not considered.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

A. Visual Observation

1. Embankment

The visual inspection of the embankment indicates that serious problems exist on this 160 year old facility. The most serious condition is the saturation of the downstream slope. Although no flow of seepage water was detected except just to the left of the spillway, and at the left abutment, large areas of the downstream slope were very soft and slippery due to saturation. The brush, weeds and small trees made close observation of possible through-seepage difficult. The toe was wet at many places. The right hillside, beyond the spillway, also had several saturated areas. At the left abutment a steady seepage, estimated at 5 gallons per minute at the time of inspection, runs down the slope into the discharge channel. This water appeared to be clear. About 100 feet to the right of the left abutment a sloughage scar indicated that sloughage had occurred some time ago (see Appendix A, Plate A-I). The top of the dam is grassed. The upstream slope has a nearly vertical drop from the crest of the dam to just below flow line over the south half (left) of its length. The rest of the upstream slope has been protected from the flow line up by a masonry and brick wall (Refer to photographs, Appendix E).

2. Appurtenant Structures

The walls along the forebay wall have fallen over, partially blocking the spillway entrance. The spillway weir and walls are in good condition. However, about 50 feet below the weir crest, at a point just below where the chute makes a sharp curve to the left, the right spillway wall was severely damaged during the tropical storm Agnes. If water flows more than a few inches deep over the spillway crest, some of the discharge runs over this low wall thus causing erosion behind the chute wall. No deep erosion has occurred because of the underlying rock, but the right chute wall has practically disappeared.

According to the available information, the upstream stone gate structure has no gate at the present. The 20-inch cast iron pipe through the embankment appears not to have a masonry support. The downstream valve is inoperable.

B. Design and Construction Data

Records of design or construction data do not exist.

C. Operating Records

Formal operating records for these facilities do not exist. The files of PennDER contain reports on inspection since 1915, indicating that seepage has been a problem since at least that year.

D. Post Construction Changes

Official records of changes to the original construction do not exist. The crest of the dam was raised at some unrecorded time to the present elevation. The upstream shear gate on the blowoff pipe was removed after a downstream valve was installed.

E. Seismic Stability

This dam is located in Seismic Zone 1 and it is considered that the static stability is sufficient to withstand minor earthquake induced dynamic forces. No studies or calculations have been made to confirm this assumption.

SECTION 7 - ASSESSMENT & RECOMMENDATIONS

7.1 DAM ASSESSMENT

A. Safety

The visual inspection, the review of available data and the operational history of this dam indicate that it is in poor condition. Considerable seepage is occurring and the overall maintenance of the facilities has not been adequate.

In accordance with the Corps of Engineers' evaluation guidelines, the combination of storage and spillway capacity is sufficient to pass only 19 percent of the Probable Maximum Flood (PMF). Overtopping of the dam with an inflow of 25 percent of the PMF would most likely cause a failure of the dam. Such a failure would significantly increase the hazard to loss of life downstream. The spillway is, therefore, considered to be seriously inadequate. The dam in its present condition is considered unsafe, non-emergency.

B. Adequacy of Information

The existing data is not considered sufficient to evalute the stability of the embankment or to assess the seriousness of the seepage.

C. Urgency

Because of the inadequacy of the spillway of this dam, and because of the uncertainties regarding the seepage conditions and the stability of the embankment, the recommendations presented in this report should be implemented immediately.

D. Necessity for Additional Studies

The results of this inspection indicate the need for additional detailed hydrologic, hydraulic, and stability studies to determine the requirements for improving the capacity of the spillway and to evalute the seepage conditions and the stability of the embankment.

7.2 RECOMMENDATIONS

A. Facilities

The following recommendations are presented for immediate action by the owner:

1. That a detailed hydrologic and hydraulic engineering investigation be conducted by a professional engineer, experienced in the design and construction of dams, to determine what measures can be taken to improve the capacity of the spillway and that an investigation be conducted to evaluate the slope seepage condition and the stability of the embankment using appropriate instrumentation.

2. That a positive method of closing the upstream end of the outlet pipe be established and that provisions be made for emergency drawdown.

B. Operation and Maintenance Procedures

It is recommended that the owner initiate the following:

1. Removal of all brush and trees from the downstream slope and establish procedures for regular maintenance of the embankment slopes and crest of dam.

2. Repair of downstream blowoff control valve.

3. Repair of the forebay walls and spillway chute.

4. Placing of riprap along the upstream slope.

5. Development of a formal surveillance and downstream warning system to be used during periods of heavy or prolonged precipitation.

APPENDIX A

CHECKLIST OF VISUAL INSPECTION REPORT

CHECK LIST

PHASE I - VISUAL INSPECTION REPORT

PA DER # 38-8 NDI NO. PA-00 599

NAME OF DAM Ebenezer Dam HAZARD CATEGORY High

TYPE OF DAM Earthfill

LOCATION North Lebanon TOWNSHIP Lebanon COUNTY, PENNSYLVANIA

INSPECTION DATE 4/6/79 WEATHER Sunny & Windy TEMPERATURE 40°

INSPECTORS: R. Houseal (Recorder) OWNER'S REPRESENTATIVE(s):

R. Shireman None

H. Jongsma

A. Bartlett

NORMAL POOL ELEVATION: 543 AT TIME OF INSPECTION:

BREAST ELEVATION: 547 (Design) POOL ELEVATION: 543.15

SPILLWAY ELEVATION: 543 TAILWATER ELEVATION:

MAXIMUM RECORDED POOL ELEVATION: Top of Embankment

GENERAL COMMENTS:

Upstream slope is very steep to one foot below waterline.

Downstream slope has many saturated areas and considerable amount of brush growth. Crest of dam is relatively wide. Spillway walls need repairs.

Local residents indicate that a small amount of water flowed over the dam breast for a few hours during the tropical storm Agnes (1972).

NDI NO. PA-00 599

VISUAL INSPECTION
EMBANKMENT

	OBSERVATIONS AND REMARKS
A. SURFACE CRACKS	Cracks at right abutment where embankment joins spillway wall. Cracks caused by failure of forebay walls.
B. UNUSUAL MOVEMENT BEYOND TOE	The spillway outlet channel flows adjacent to the downstream toe of the embankment. None observed beyond toe. Some soft spots.
C. SLOUGHING OR EROSION OF EMBANKMENT OR ABUTMENT SLOPES	The downstream slope is not uniform. There is evidence of sloughage and movement of the surface along the length of the embankment. Also several groundhog holes were noted on the downstream slope. One slippage occurred (see Plate A-I and A-III).
D. ALIGNMENT OF CREST: HORIZONTAL: VERTICAL:	Horizontal alignment good
E. RIPRAP FAILURES	No riprap except possibly below waterline on upstream side. Top 4 feet steep.
F. JUNCTION EMBANKMENT & ABUTMENT OR SPILLWAY	Left abutment with original ground is saturated and water is seeping to the stream below. Right abutment with spillway is deteriorated with walls falling into spillway approach channel and portions of embankment sloughing into water.
G. SEEPAGE	Active seepage at left abutment. Numerous saturated areas along the downstream slope about 10 feet from top. Seepage into spillway channel from behind left wall. Est. 30 gpm ±.
H. DRAINS	None evident.
J. GAGES & RECORDER	None.
K. COVER (GROWTH)	Upstream slope nearly vertical to water's edge. Part of upstream side has masonry block wall extending to spillway on right side of embankment. Downstream slope covered with vines, brush and many small trees about 1" in size. Top partially grassed with some weed growth on left end of crest.

NDI NO. PA-00 599

VISUAL INSPECTION
OUTLET WORKS

	OBSERVATIONS AND REMARKS
A. INTAKE STRUCTURE	Abandoned gate structure. No operable closure.
B. OUTLET STRUCTURE	Inoperable valve at end of a 20-inch cast iron pipe with small headwall. Pipe probably not encased.
C. OUTLET CHANNEL	None.
D. GATES	None.
E. EMERGENCY GATE	Inoperable valve.
F. OPERATION & CONTROL	None.
G. BRIDGE (ACCESS)	None.

NDI NO. PA-00 599

VISUAL INSPECTION
SPILLWAY

	OBSERVATIONS AND REMARKS
A. APPROACH CHANNEL	Directly from reservoir - short approach to spillway crest. Retaining walls on both sides have collapsed into the channel as well as small portions of the embankment.
B. WEIR: Crest Condition Cracks Deterioration Foundation Abutments	 Good - flat. None. None. Not visible. Good.
C. DISCHARGE CHANNEL: Lining Cracks Stilling Basin	 Concrete paved on stone base. Right masonry spillway wall seriously deteriorated. None. Discharge channel does not control flow.
D. BRIDGE & PIERS	8" concrete slab across spillway walls acts as a footbridge.
E. GATES & OPERATION EQUIPMENT	None.
F. CONTROL & HISTORY	None recorded.

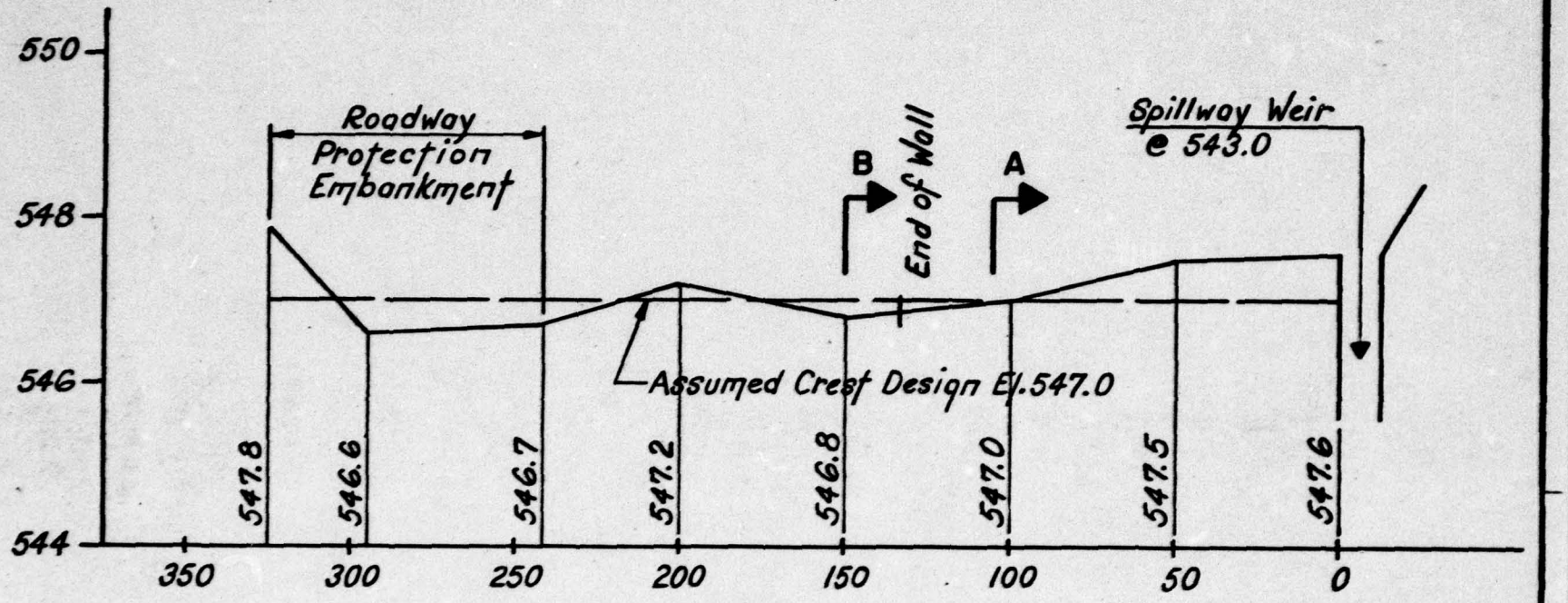
NDI NO. PA-00 599

VISUAL INSPECTION

	OBSERVATIONS AND REMARKS
INSTRUMENTATION Monumentation	None.
Observation Wells	None.
Weirs	None.
Piezometers	None.
Staff Gauge	None.
Other	None.
RESERVOIR Slopes	Cultivated fields, grassed recreation area. Beaches.
Sedimentation	Unknown.
Watershed Description	Residential and agriculture.
DOWNSTREAM CHANNEL Condition	Natural small stream channel. Stream flows through two 18-inch concrete pipes beneath highway about 250 feet downstream.
Slopes	Cultivated fields.
Approximate Population	8 in several homes and farms.
No. Homes	About 5 homes and farms in the first mile downstream.

EBENEZER DAM
PA-599
INSPECTION SURVEY

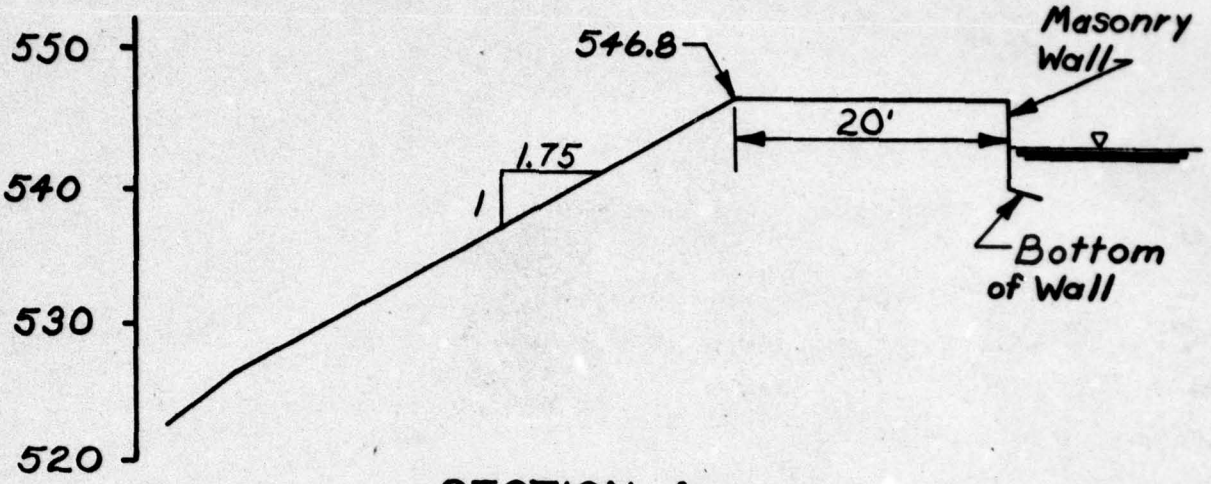
4-6-79 PLATE A-I



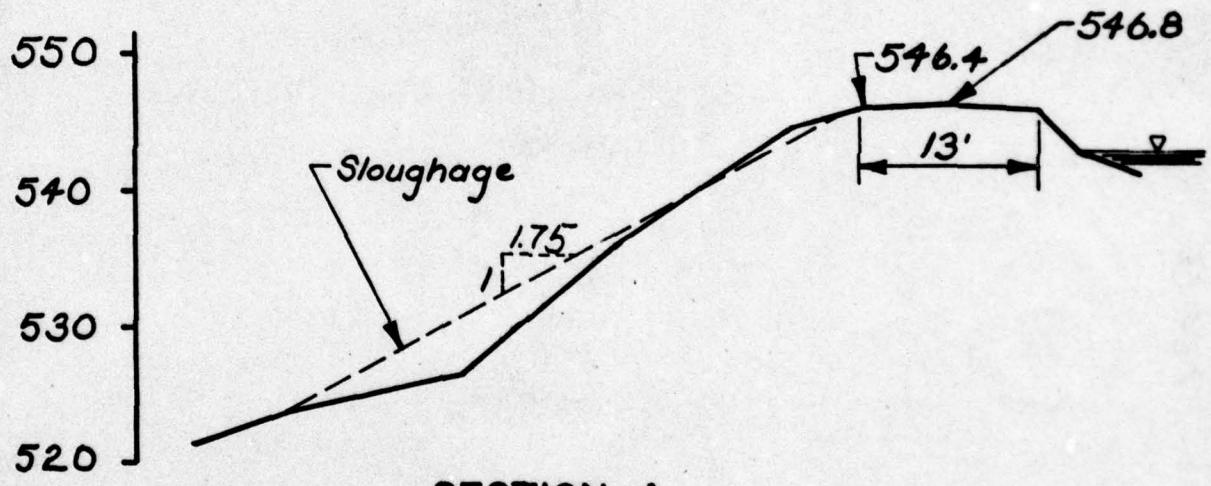
EMBANKMENT PROFILE

EBENEZER DAM
PA.599
INSPECTION SURVEY

PLATE A-II



SECTION A



SECTION A

EBENEZER DAM
PA.599
INSPECTION SURVEY

PLATE A-III

APPENDIX B

CHECKLIST OF ENGINEERING DATA

CHECK LIST
ENGINEERING DATA

PA DER # 38-8 NDI NO. PA-00 599

NAME OF DAM Ebenezer Dam

ITEM	REMARKS
AS-BUILT DRAWINGS	None.
REGIONAL VICINITY MAP	U.S.G.S. Quadrangle - Lebanon, PA See Plate II, Appendix F
CONSTRUCTION HISTORY	None.
GENERAL PLAN OF DAM	None. See Plate III, Appendix F.
TYPICAL SECTIONS OF DAM	None.
OUTLETS: PLAN DETAILS CONSTRAINTS DISCHARGE RATINGS	None.

NDI NO. PA-00 599

ENGINEERING DATA

ITEM	REMARKS
RAINFALL & RESERVOIR RECORDS	None.
DESIGN REPORTS	None.
GEOLOGY REPORTS	None.
DESIGN COMPUTATIONS: HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	None.
MATERIALS INVESTIGATIONS: BORING RECORDS LABORATORY FIELD	None.
POST CONSTRUCTION SURVEYS OF DAM	None, except inspection reports by PennDER.
BORROW SOURCES	Unknown.

NDI NO. PA-00 599

ENGINEERING DATA

ITEM	REMARKS
MONITORING SYSTEMS	None at present. Weir readings for leakage in 1919 and 1927
MODIFICATIONS	None recorded, except bringing dam crest up to top of spillway walls in 1932.
HIGH POOL RECORDS	Inspection report indicates that dam was over-topped in Spring of 1920, due to clogging of spillway by drifted snow.
POST CONSTRUCTION ENGINEERING STUDIES & REPORTS	None.
PRIOR ACCIDENTS OR FAILURE OF DAM Description: Reports:	None reported.
MAINTENANCE & OPERATION RECORDS	None.
SPILLWAY PLAN, SECTIONS AND DETAILS	None.

NDI NO. PA-00 599

ENGINEERING DATA

ITEM	REMARKS
OPERATING EQUIPMENT, PLANS & DETAILS	None.
CONSTRUCTION RECORDS	None.
PREVIOUS INSPECTION REPORTS & DEFICIENCIES	Inspection reports in PennDER files since 1915.
MISCELLANEOUS	

NDI NO. PA-00 599

CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Agriculture and housing developments.

ELEVATION:

TOP NORMAL POOL & STORAGE CAPACITY: Elev. 543 123 Acre-Feet

TOP FLOOD CONTROL POOL & STORAGE CAPACITY: Elev.546.6 166 Acre-Feet

MAXIMUM DESIGN POOL: Elev. Unknown

TOP DAM: Elev. Unknown

SPILLWAY:

a. Elevation 543

b. Type Broadcrested Weir

c. Width 12 feet.

d. Length 120 feet.

e. Location Spillover Right Abutment.

f. Number and Type of Gates None.

OUTLET WORKS:

a. Type 20-inch pipe with 12-inch valve.

b. Location Under embankment.

c. Entrance inverts 523±

d. Exit inverts 522±

e. Emergency drawdown facilities Inoperable 12-inch valve.

HYDROMETEOROLOGICAL GAGES:

a. Type None.

b. Location

c. Records None.

MAXIMUM NON-DAMAGING DISCHARGE: 230 cfs.

SUMMARY OF INSPECTION REPORTS

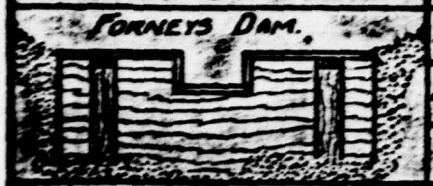
March, 1919	-	Dam still in same condition.
July, 1920	-	Twelve-inch wide weir measured 303,000 gallon/day.
July, 1927	-	Excessive leakage at the left end of dam. A new 12-inch wide, 4-inch deep weir was installed. For readings see Page B-7. It is not recorded where the weir was installed and what pool levels occurred.
March, 1929	-	Considerable leakage at left end and through embankment. Upstream slope eroded by wave action.
May, 1932	-	Reported that top of dam was brought up to spillway wall elevation.
May, 1934	-	Brush on slopes and two settlement holes; one on upstream edge of crest and one on the upstream slope. Both holes located close to the road.
May, 1938	-	Installation of weir requested. No readings available.
September, 1945	-	Crest uneven and narrow. Downstream slope with heavy growth of trees and brush. Grouted riprap on upstream slope deteriorated and displaced.
May, 1959	-	Brush and trees. Considerable leakage at blowoff pipe.
July, 1970	-	Considerable leakage at valve. Please remove pine trees on downstream slope, planted for beautification.

WEIR READINGS

Date	Depth of Flow Inches	Gallons/Minute C=3.3	Gallons/Day
9/2/27	2-3/8	130.4	187,800
9/8/27	1-1/2	65.4	94,200
9/13/27	1-3/4	82.5	118,800
9/16/27	2-1/4	120.2	173,100
9/21/27	2-1/4	120.2	173,100
10/10/27	2-1/2	140.8	202,800
11/15/27	1-7/8	91.4	131,600
6/7/28	2	100.7	145,000
6/15/28	1-1/8	42.5	61,200
7/20/28	1-7/8	91.4	131,600
8/10/28	1-7/8	91.4	131,600
8/20/28	1-5/8	73.8	106,300
8/31/28	1-1/2	65.4	94,200
9/14/28	1-3/8	57.4	82,700
10/12/28	1-5/8	73.8	106,300
11/16/28	1-1/4	49.8	71,700
12/5/28	5/8	17.6	25,300
12/28/28	1-1/4	49.8	71,700
1/11/29	1-3/8	57.4	82,700
1/25/29	1-5/8	73.8	106,300
2/8/29	1-1/4	49.8	71,700
2/22/29	1-3/8	57.4	82,700

DATE	4/13/20	5/24/20	5/28/20	5/5/20	5/7/20	5/14/20	5/19/20	5/26/20	6/2/20	6/10/20	6/17/20	6/23/20	6/30/20	7/6/20	7/15/20	7/21/20	7/28/20	8/4/20	8/11/20	8/19/20	8/26/20	9/2/20	9/9/20
DEPTH	4 5/8"	5 5/8"	4 5/8"	4"	4"	3"	3 1/2"	3 1/4"	1 3/8"	1 1/4"	2 5/8"	2"	2 1/4"	2"	2 5/8"	1 7/8"	1 7/8"	2"	2 5/8"	3"	2 3/4"		
SIZE	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"		

DATE	4/13/20	4/21/20	5/28/20	5/5/20	5/7/20	5/14/20	5/19/20	5/26/20	6/2/20	6/10/20	6/17/20	6/23/20	6/30/20	7/6/20	7/15/20	7/21/20	7/28/20	8/4/20	8/11/20	8/19/20	8/26/20	9/2/20	9/9/20
DEPTH	4 1/2"	5"	4 3/8"	4 1/8"	4 1/8"	2 3/8"	3 3/8"	3 1/2"	*														
SIZE	12"	12"	12"	12"	12"	12"	12"	12"	12"														



DATE	4/13/20	4/21/20	4/28/20	5/5/20	5/7/20	5/14/20	5/19/20	5/26/20	6/2/20	6/10/20	6/17/20	6/23/20	6/30/20	7/6/20	7/15/20	7/21/20	7/28/20	8/4/20	8/11/20	8/19/20	8/26/20	9/2/20	9/9/20
DEPTH	2"	2 3/4"	1 3/4"	1 3/8"	1 3/4"	1"	3/8"	1/2"	1 1/2"	1 1/2"	3/4"	3/4"	5/8"	1/2"	1/2"	1 1/2"	1 1/2"	3/8"	1 3/4"	1 3/4"	1 1/2"		
SIZE	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"		

DATE	4/13/20	4/21/20	4/28/20	5/5/20	5/7/20	5/14/20	5/19/20	5/26/20	6/2/20	6/10/20	6/17/20	6/23/20	6/30/20	7/6/20	7/15/20	7/21/20	7/28/20	8/4/20	8/11/20	8/19/20	8/26/20	9/2/20	9/9/20
DEPTH	1 7/8"	1 3/4"	1 1/2"	1 3/4"	1 3/8"	1 3/8"	1 3/4"	1 1/2"	1 3/8"	1 1/4"	1 3/8"	1 3/8"	1 3/8"	1 1/2"	1 1/2"	1 3/8"	1 1/4"	1 3/8"	1 3/8"	1 3/8"	1 5/8"	1 5/8"	
SIZE	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	

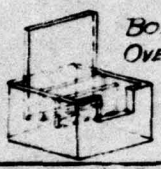
DATE	4/13/20	4/21/20	4/28/20	5/5/20	5/7/20	5/14/20	5/19/20	5/26/20	6/2/20	6/10/20	6/17/20	6/23/20	6/30/20	7/6/20	7/15/20	7/21/20	7/28/20	8/4/20	8/11/20	8/19/20	8/26/20	9/2/20	9/9/20
DEPTH	1 1/2"	1 5/8"	1 3/8"	1 1/8"	1 1/8"	1 1/8"	1"	7/8"	3/4"	3/4"	5/8"	3/4"	3/4"	1"	7/8"	1 1/2"	3/4"	3/4"	3/4"	7/8"	7/8"		
SIZE	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	10"	10"	10"	10"	10"	10"	10"	10"	10"		

* NOTE:
NEW VALVE INSTALLED.

EBENEZER DAM - WEIR IN STREAM

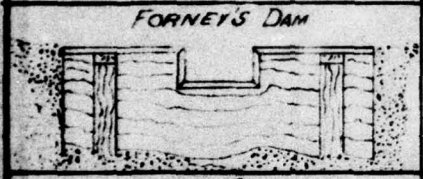
DATE	4/8/19	4/14/19	4/22/19	4/30/19	5/8/19	5/14/19	5/22/19	5/29/19	6/4/19	6/11/19	6/18/19	6/27/19	7/3/19	7/16/19	7/23/19	7/30/19	8/6/19	8/13/19	8/20/19
DEPTH	3 1/2"	3 1/2"	3 3/8"	3 3/8"	3 3/8"	3 11/16"	4"	3 7/8"	3 1/2"	3 1/4"	3 1/8"	3 1/4"	3 1/4"	3"	4"	4"	2"	2"	2 3/4"
SIZE	17"	17"	17"	17"	17"	17"	17"	17"	17"	17"	17"	17"	17"	17"	18"	18"	18"	18"	18"

BOX WEIR AT OVERFLOW PIPE



DATE	4/3/19	4/14/19	4/22/19	4/30/19	5/8/19	5/14/19	5/22/19	5/29/19	6/4/19	6/11/19	6/18/19	6/27/19	7/3/19	7/16/19	7/23/19	7/30/19	8/6/19	8/13/19	8/20/19
DEPTH	2"	2 3/16"	2 1/4"	2 1/8"	2 1/16"	2 3/8"	2 5/8"	2 3/4"	2"	2"	2"	2 1/4"	2 1/4"	2 1/4"	4"	4"	3"	3"	3"
SIZE	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	12"	12"	12"	12"	12"

FORNEY'S DAM



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DEPTH	1 3/8"	1 3/8"	1 3/8"	1 1/2"	1 3/16"	1 3/8"	1 3/4"	1 1/2"	1 1/4"	1 1/2"	1 3/8"	1 3/8"	1 3/8"	1 3/4"	1 15/16"	1 13/16"	1"	1 1/4"	1 1/2"
SIZE	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"

STOEVERS DAM - 2 WEIRS

#1

DATE	4/8/19	4/14/19	4/22/19	4/30/19	5/8/19	5/14/19	5/22/19	5/29/19	6/4/19	6/11/19	6/18/19	6/27/19	7/3/19	7/16/19	7/23/19	7/30/19	8/6/19	8/13/19	8/20/19
DEPTH	2"	1 7/8"	2 1/16"	2"	2 3/8"	2"	2 1/4"	2 1/4"	1 13/16"	1 7/8"	2"	2"	1 3/4"	1 11/16"	1 1/2"	1 1/2"	1 3/4"	1 1/2"	1 1/2"
SIZE	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"

#2

DATE	4/8/19	4/14/19	4/22/19	4/30/19	5/8/19	5/14/19	5/22/19	5/29/19	6/4/19	6/11/19	6/18/19	6/27/19	7/3/19	7/16/19	7/23/19	7/30/19	8/6/19	8/13/19	8/20/19
DEPTH	1 15/16"	1 13/16"	2"	1 13/16"	1 13/16"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 7/8"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"
SIZE	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"

1

8/27/19	9/3/19	9/10/19	9/17/19	9/24/19	9/30/19	10/7/19	10/14/19	10/21/19	10/28	11/4/19	11/12/19	11/26/19	12/3/19	12-10-19	12-17-19	12-23-19	12-31-19	1-7-20	1-14-20	1/21/20	1/28/20	2/4/20	2/11/20	2/18/20	2/25/20	3/3/20	[illegible]
1 3/4"	2 1/2"	2 7/8"	2 1/4"	2 1/4"	1 3/4"	1 3/4"	1 1/2"	1 3/4"	1 1/2"	2"	1 3/4"	1 1/2"	1 1/4"	1 1/2"	3 1/4"	3 1/4"	3"	3"	3 1/4"	3"	2 1/2"		2 3/4"	1 5/8"	1 5/8"	1 5/8"	5
18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	18"	19"	18"	18
8/27/19	9/13/19	9/10/19	9/17/19	9/24/19	9/30/19	10/7/19	10/14/19	10/21/19	10/28	11/4/19	11/12/19	11/26/19	12-3-19	12-10-19	12-17-19	12-23-19	12-31-19	1-7-20	1-14-20	1/21/20	1/28/20	2/4/20	2/11/20	2/18/20	2/25/20	3/3/20	[illegible]
3"	2 3/4"	2 7/8"	2 1/4"	1 3/4"	1 3/4"	1 3/4"	1 1/2"	2"	1 1/2"	1 3/4"	2"	1 1/4"	1"	7/8"	1 1/2"	1 1/4"	1 1/2"	1"	1"	1 1/2"	1 1/2"	1"	1 1/2"	1 3/8"	1 5/8"	1 5/8"	5
12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12"	12
8/27/19	9/3/19	9/10/19	9/17/19	9/24/19	9/30/19	10/7/19	10/14/19	10/21/19	10/28	11/4/19	11/12/19	11/20/19	12-3-19	12-10-19	12-17-19	12-23-19	12-31-19	1-7-20	1-14-20	1/21/20	1/28/20	2/4/20	2/11/20	2/18/20	2/25/20	3/3/20	[illegible]
1"	1"	1"	7/8"	3/4"	1"	1"	1"	1"	1"	7/8"	1"	1 1/4"	1"	2"	3 1/2"	2"	2 1/4"	1 3/4"	1"	7/8"	3/4"	1"	1 1/8"	1/2"	5/8"	1/2"	1
14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14"	14
8/27/19	9/3/19	9/10/19	9/17/19	9/24/19	9/30/19	10/7/19	10/14/19	10/21/19	10/28	11/4/19	11/12/19	11/20/19	12-3-19	12-10-19	12-17-19	12-23-19	12-31-19	1-7-20	1-14-20	1/21/20	1/28/20	2/4/20	2/11/20	2/18/20	2/25/20	3/3/20	[illegible]
1 3/4"	2"	2"	2"	1 3/4"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 1/2"	1 5/8"	1 1/2"	1 1/8"	1"	7/8"	1 1/2"	1 1/4"	1 5/8"	1"	1"	1 1/4"	1 1/4"	1"	1 1/4"	7/8"	1 1/8"	3/4"	3
10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10"	10
9/27/19	9/3/19	9/10/19	9/17/19	9/24/19	9/30/19	10/7/19	10/14/19	10/21/19	10/28	11/4/19	11/12/19	11/26/19	12-3-19	12-10-19	12-17-19	12-23-19	12-31-19	1-7-20	1-14-20	1/21/20	1/28/20	2/4/20	2/11/20	2/18/20	2/25/20	3/3/20	[illegible]
1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 5/8"	1 3/4"	1"	1"	1 3/4"	1 3/4"	1 3/4"	1 3/4"	1 1/4"	1 1/2"	1 3/4"	1 3/4"	1 3/4"	1 1/8"	1"	3
8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8"	8

+ INDICATES ST[R]
ABOVE NORMAL

2

+ INDICATES STREAM
ABOVE NORMAL

2

3

APPENDIX C

HYDROLOGY AND HYDRAULIC CALCULATIONS

SUMMARY DESCRIPTION
OF
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION

The hydrologic and hydraulic evaluation for this inspection report has employed computer techniques using the Corps of Engineers computer program identified as the Flood Hydrograph Package (HEC-1) Dam Safety Version.

The program has been designed to enable the user to perform two basic types of hydrologic analyses: (1) the evaluation of the overtopping potential of the dam, and (2) the capability to estimate the downstream hydrologic-hydraulic consequences resulting from assumed structural failures of the dam. A brief summary of the computation procedures typically used in the dam overtopping analysis is shown below.

- Development of an inflow hydrograph to the reservoir.
- Routing of the inflow hydrograph(s) through the reservoir to determine if the event(s) analyzed would overtop the dam.
- Routing of the outflow hydrograph(s) of the reservoir to desired downstream locations. The results provide the peak discharge, time of the peak discharge and maximum stage of each routed hydrograph at the outlet of the reach.

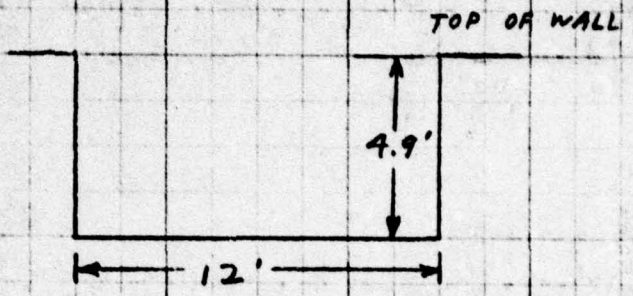
The output data provided by this program permits the comparison of downstream conditions just prior to a breach failure with that after a breach failure and the determination as to whether or not there is a significant increase in the hazard to loss of life as a result of such a failure.

The results of the studies conducted for this report are presented in Section 5.

For detailed information regarding this program refer to the Users Manual for the Flood Hydrograph Package (HEC-1) Dam Safety Version prepared by the Hydrologic Engineering Center, U. S. Army Corps of Engineers, Davis, California.

BY RLS DATE 4/10/29 | BERGER ASSOCIATES | SHEET NO. 1 OF
CHKD. BY DATE | PROJECT DB490
SUBJECT EBENEZER DAM

SPILLWAY CHANNEL CAPACITY



$S = .016$

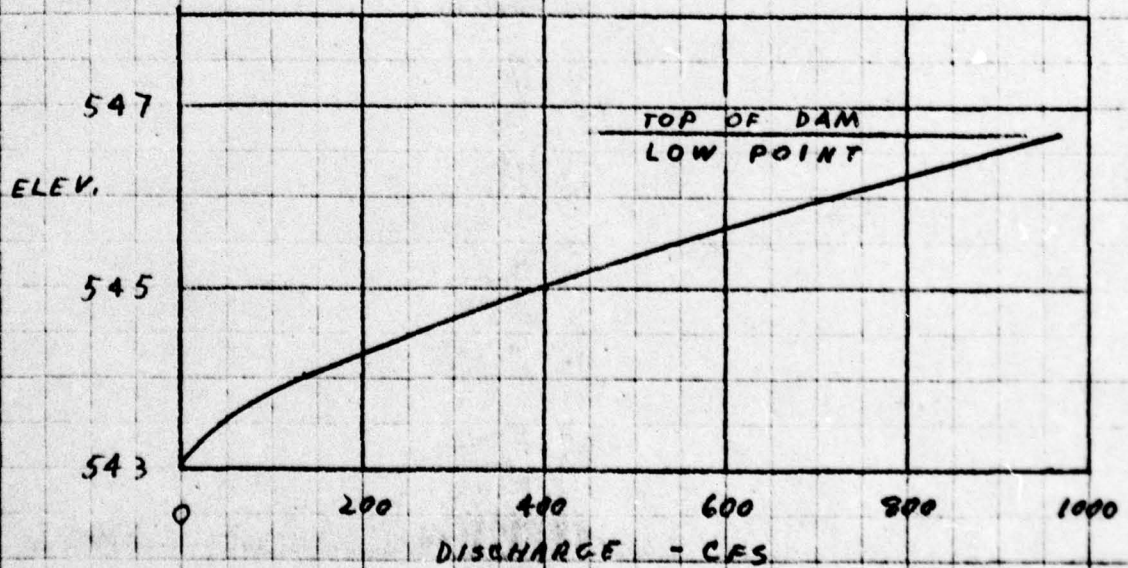
$N = .015$ (CHOW; OPEN-CHANNEL)

$$Q = \frac{1.486}{N} A R^{2/3} S^{1/2}$$

$$= \frac{1.486}{.015} \times 58.8 \times 1.95 \times .1265$$

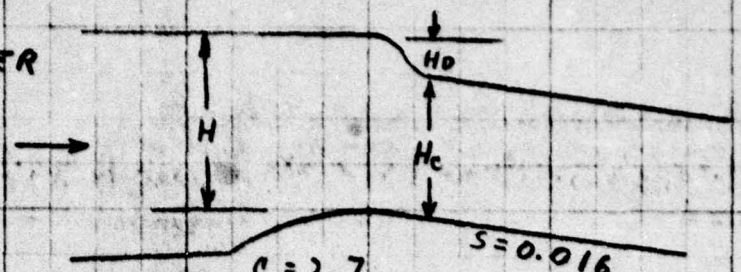
$$= 1436 \text{ CFS} \quad \text{FLOWING FULL}$$

SPILLWAY CHUTE RATING CURVE



BY RLS DATE 4/11/79 | BERGER ASSOCIATES | SHEET NO. 2 OF
CHKD. BY DATE | PROJECT D.8490
SUBJECT EBENEZER DAM

WEIR TAILWATER



Q_A	Hc	H	Ho	Ho/H	Cs (FIG. 254 SMALL DAMS)	Q
50	.55	1	.45	.45	2.62	31
		1.5	.95	.63	2.67	59
		1.3	.75	.58	2.66	47
100	.85	1.7	.85	.5	2.65	70
		2	1.15	.58	2.66	90
		2.25	1.4	.62	2.67	108
150	1.1	2.6	1.5	.58	2.66	134
		2.8	1.7	.61	2.67	150
200	1.3	3.4	2.1	.62	2.67	201
250	1.5	3.9	2.4	.62	2.67	247

VERY LITTLE VARIATION IN C_S

USE C = 2.67

BY RLS DATE 9/11/79 | BERGER ASSOCIATES | SHEET NO. 3 OF
CHKD. BY DATE | PROJECT D8490
SUBJECT EBENEZER DAM

MAXIMUM KNOWN FLOOD AT DAM SITE

THE MAXIMUM KNOWN FLOOD AT EBENEZER DAM OCCURRED IN JUNE 1972. DURING THIS EVENT THE WATER LEVEL REACHED THE TOP OF THE DAM. IN ORDER TO PREVENT WATER FROM OVERTOPPING, A CUT WAS MADE IN THE PROTECTIVE EMBANKMENT ALONG THE ROADWAY, AND THE RELIEF DISCHARGE FLOWED DOWN THE ROAD. THE SIZE OF THE EXCAVATION IS UNKNOWN.

THE MAXIMUM SPILLWAY DISCHARGE WAS:

$H = 3.7'$

$Q = C L H^{3/2}$

$= 2.67 \times 12 \times (3.7)^{1.5}$

$= 228$ CFS SAY 230 CFS

ESTIMATED MAXIMUM INFLOW

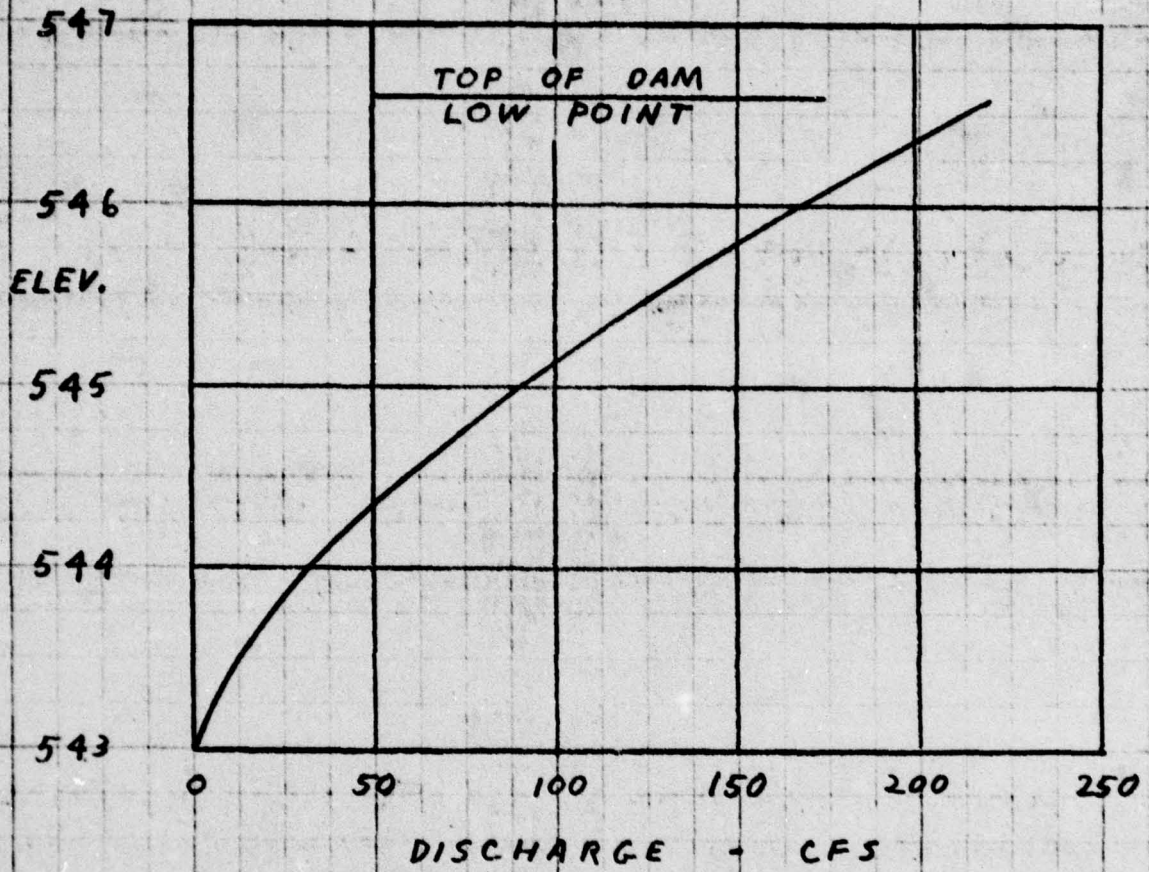
BECK CREEK IS A NEARBY TRIBUTARY IN THE SWATARA CREEK DRAINAGE BASIN. FOR THE U.S.G.S. GAGING STATION LOCATED ON BECK CREEK NEAR CLEONA, THE PEAK DISCHARGE FOR THE PERIOD OF OF RECORD 1963 TO 1978 WAS 5150 CFS ON JUNE 22, 1972. THE DRAINAGE AREA AT THE GAGING STATION IS 7.87 SQ. MI.

APPROXIMATE EBENEZER DAM INFLOW:

$$\left(\frac{0.5}{7.87}\right)^{.8} \times 5150 = 568 \text{ CFS} \quad \text{SAY } 570 \text{ CFS}$$

BY RLS DATE 9/11/79 BERGER ASSOCIATES SHEET NO. 4 OF
CHKD. BY DATE PROJECT D8490
SUBJECT EBENEZER DAM

SPILLWAY RATING CURVE



BY RLS DATE 4/16/79 BERGER ASSOCIATES SHEET NO. 5 OF
CHKD. BY DATE PROJECT D.8490
SUBJECT EBENEZER DAM

DISCHARGE THROUGH OUTLET WORKS

12" VALVE ON DOWNSTREAM END OF 20" CAST IRON PIPE

ELEV. CENTER OF VALVE (ORIFICE) = APPROX. 522.5

APPROX. DISCHARGE AT POOL LEVEL 543

$H = 543 - 522.5 = 20.5$

$Q = CA\sqrt{2gH}$ $C = 0.6$

$= 0.6 \times \pi/4 \times \sqrt{2 \times 32.2 \times 20.5}$

$= 17$ CFS

APPROX. DISCHARGE AT POOL LEVEL 525

$H = 525 - 522.5 = 2.5$

$Q = CA\sqrt{2gH}$

$= 0.6 \times \pi/4 \times \sqrt{2 \times 32.2 \times 2.5}$

$= 6$ CFS

BY RLS DATE 4/12/79 | BERGER ASSOCIATES | SHEET NO. 6 OF
CHKD. BY DATE | PROJECT D8490
SUBJECT EBENEZER DAM

EMBANKMENT RATING

ELEV. 546.7

$2.7 \times 55 \times .05^{3/2} = 2$

ELEV. 546.8

$2.7 \times 55 \times .15^{3/2} = 9$

$2.7 \times 10 \times .05^{3/2} = .3$ $\quad \Sigma = 9$

ELEV. 547

$2.7 \times 55 \times .35^{3/2} = 31$

$2.7 \times 10 \times .25^{3/2} = 3$

$2.7 \times 99 \times .1^{3/2} = 8$ $\quad \Sigma = 42$

ELEV. 547.2

$2.7 \times 55 \times .55^{3/2} = 61$

$2.7 \times 10 \times .45^{3/2} = 8$

$2.7 \times 99 \times .3^{3/2} = 44$

$2.7 \times 66 \times .1^{3/2} = 6$ $\quad \Sigma = 119$

ELEV. 547.5

$2.7 \times 55 \times .85^{3/2} = 116$

$2.7 \times 10 \times .75^{3/2} = 18$

$2.7 \times 99 \times .6^{3/2} = 124$

$2.7 \times 66 \times .4^{3/2} = 45$

$2.7 \times 37 \times .15^{3/2} = 6$ $\quad \Sigma = 309$

ELEV. 547.6

$2.7 \times 55 \times .95^{3/2} = 138$

$2.7 \times 10 \times .85^{3/2} = 21$

$2.7 \times 99 \times .7^{3/2} = 156$

$2.7 \times 66 \times .5^{3/2} = 63$

$2.7 \times 37 \times .25^{3/2} = 12$

$2.7 \times 52 \times .05^{3/2} = 2$ $\quad \Sigma = 392$

ELEV. 547.8

$2.7 \times 55 \times 1.15^{3/2} = 183$

$2.7 \times 10 \times 1.05^{3/2} = 29$

$2.7 \times 99 \times .9^{3/2} = 228$

$2.7 \times 66 \times .7^{3/2} = 104$

$2.7 \times 37 \times .45^{3/2} = 30$

$2.7 \times 52 \times .25^{3/2} = 19$

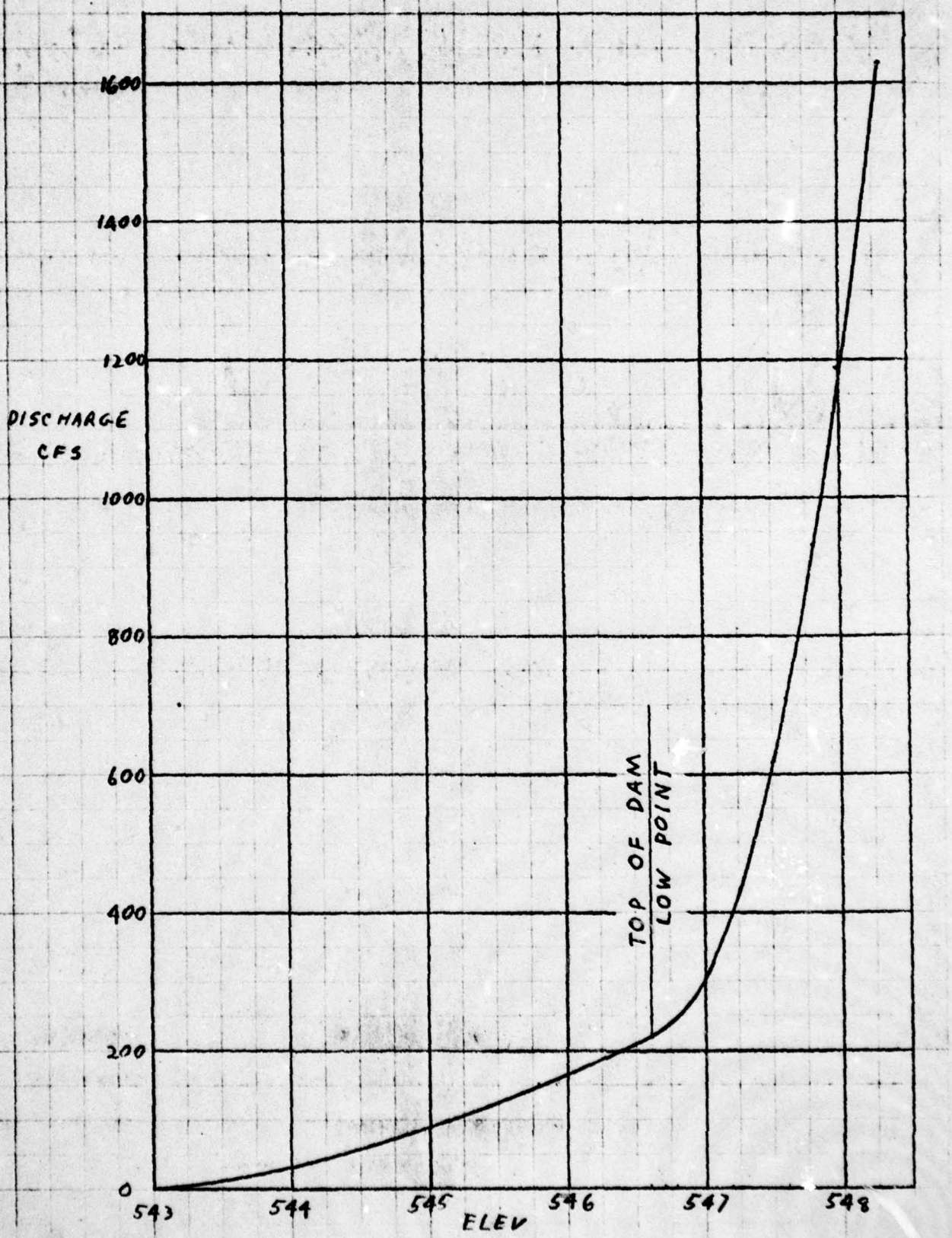
$2.7 \times 10 \times .1^{3/2} = 1$ $\quad \Sigma = 593$

BY RLS DATE 9/12/79 | BERGER ASSOCIATES | SHEET NO. 7 OF

CHKD. BY DATE | PROJECT D8490

SUBJECT EBENEZER DAM

DISCHARGE RATING CURVE



BY RLS DATE 4/12/79 BERGER ASSOCIATES SHEET NO. 8 OF
CHKD. BY DATE PROJECT D8490
SUBJECT EBENEZER DAM

SIZE CLASSIFICATION
MAXIMUM STORAGE = 166 ACRE-FEET
MAXIMUM HEIGHT = 25 FEET
SIZE CLASSIFICATION IS SMALL

HAZARD CLASSIFICATION
SEVERAL HOUSES ARE LOCATED NEAR THE DOWNSTREAM CHANNEL
USE "HIGH"

RECOMMENDED SPILLWAY DESIGN FLOOD
THE ABOVE CLASSIFICATIONS INDICATE USE OF AN SDF EQUAL TO 1/2 THE PROBABLE MAXIMUM FLOOD TO THE PROBABLE MAXIMUM FLOOD.

BY RLS DATE 9/12/79 | BERGER ASSOCIATES | SHEET NO. 9 OF
CHKD. BY DATE | PROJECT D849.0
SUBJECT EBENEZER DAM

HEC-1 DATA

DRAINAGE AREA = 0.5 SQ. MI.

SUSQUEHANNA BASIN REGION 15B
$C_P = .85$
$C_T = 2.20$
LONGEST WATER COURSE = 1.43 MI.
L TO CENTROID = .59 MI.

$T_P = C_T (L \times L_{CA})^{.3}$
$T_P = 2.09$

RAINFALL (HMR-33)
INDEX (200 SQ. MI. - 24 HR.) = 23.2"

ZONE 6

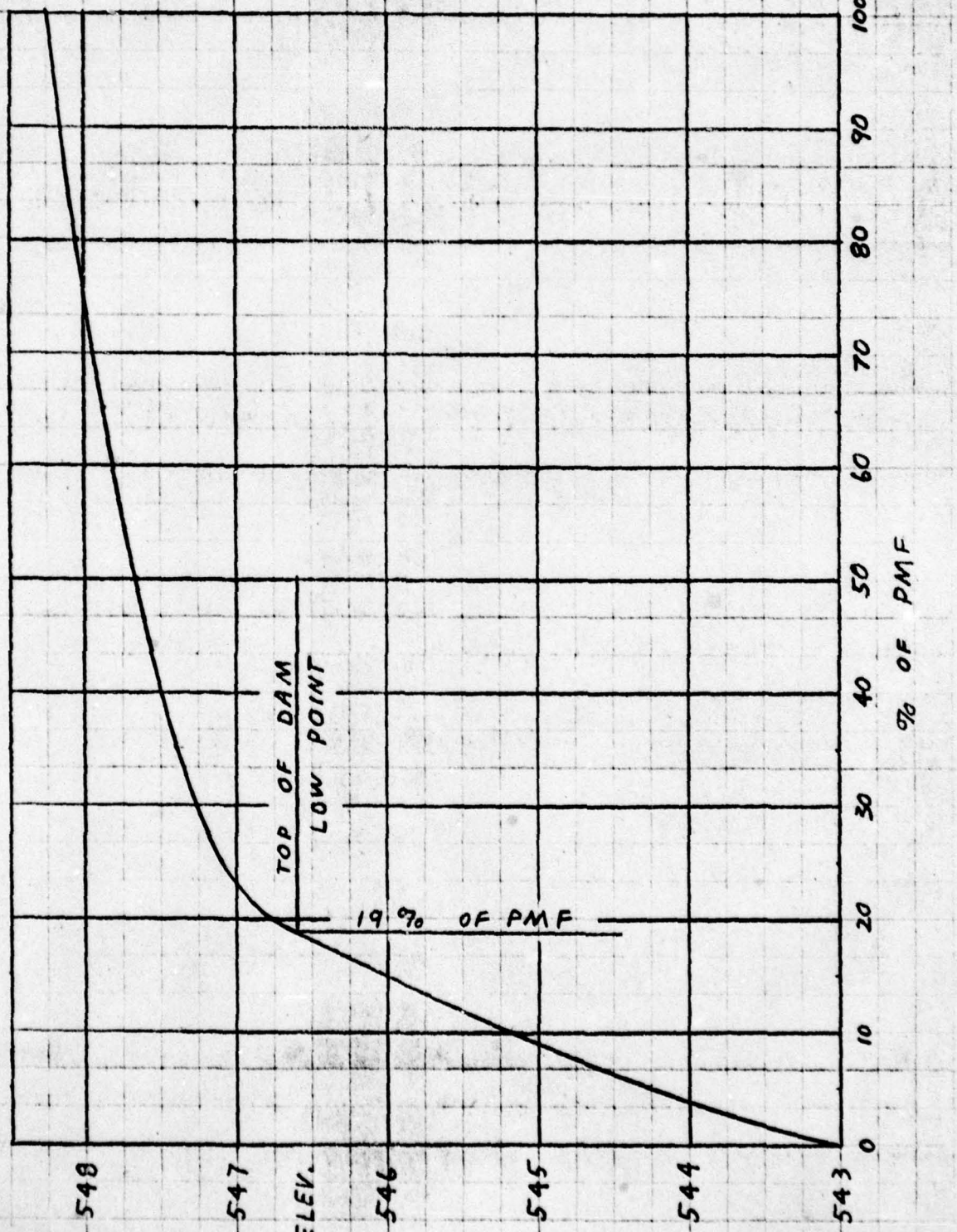
INCREMENTAL RAINFALL
6 HR = 113 %
12 HR = 123 %
24 HR = 132 %
48 HR = 143 %

PLANIMETERED AREAS (FROM QUAD SHEET)
ELEV: 543 = 10.1 ACRES
560 = 33.4 ACRES

ZERO STORAGE ELEVATION
ELEV. = 543 - (STORAGE × 3/AREA)
= 506.5

BY RLS DATE 4/12/79 BERGER ASSOCIATES SHEET NO. 10 OF
CHKD. BY DATE PROJECT D8490
SUBJECT EBENEZER DAM

SPILLWAY CAPACITY CURVE



BY RLS DATE 4/13/79 | BERGER ASSOCIATES | SHEET NO. ____ OF ____

CHKD. BY ____ DATE ____ | PROJECT D8490

SUBJECT EBENEZER DAM

SPILLWAY CAPACITY CURVE

IMPROVED EMBANKMENT

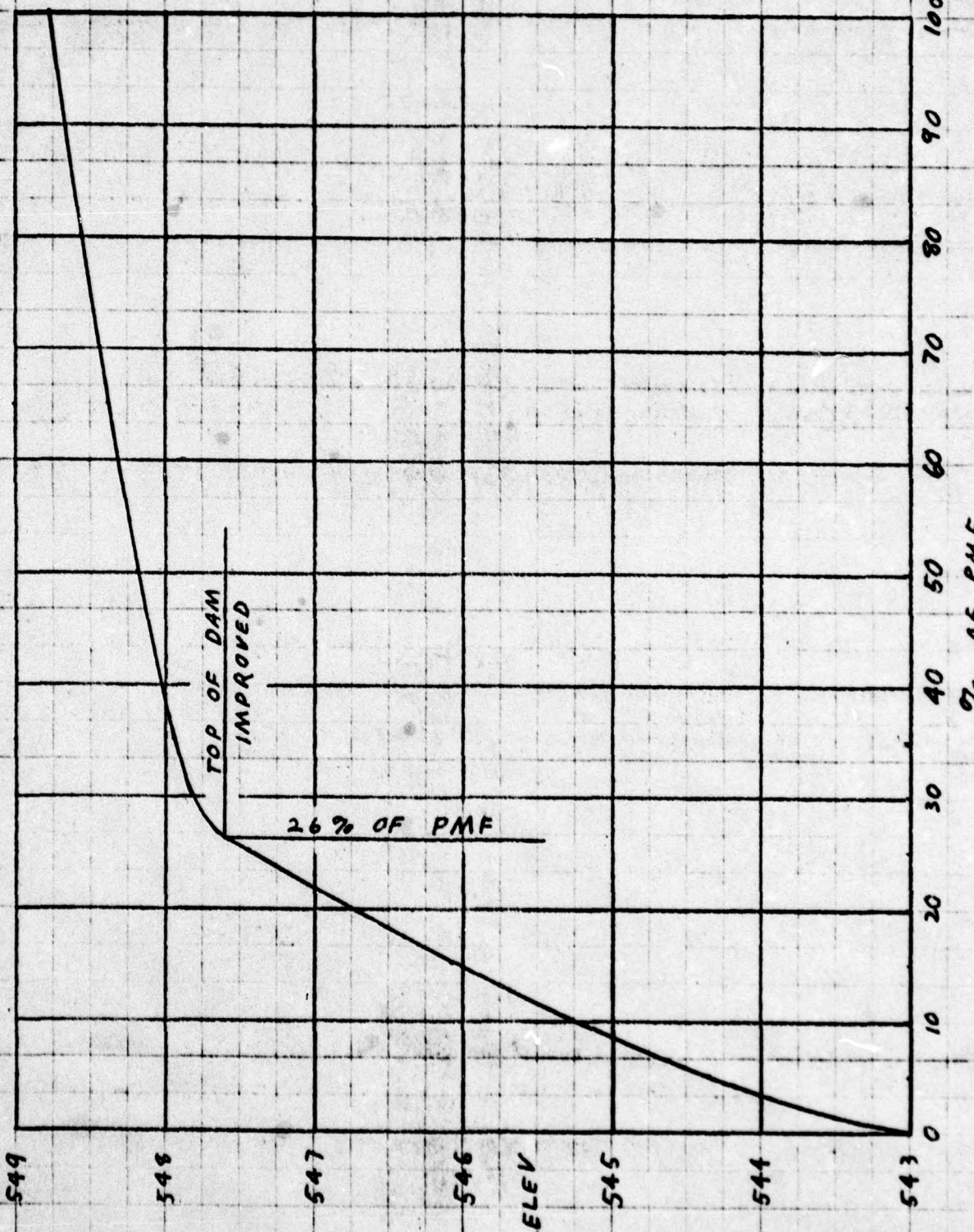


TABLE NO.1

COMPARISON OF WATER SURFACE ELEVATIONS

EBENEZERS DAM

PMF = 1,560 cfs

Crest Elevation - 547.6 Low Point - 546.6 Spillway Elevation - 543.0

	STAGE	CREST OF DAM ELEVATION	DEPTH	500' D/S OF DAM* ELEVATION
A.	At Low Point in Embankment Crest	546.6	0	524.2
B.	25% PMF Overtopping No Breach	547.11	.51	524.7
C.	25% PMF Overtopping (15 Min. Breach)	547.1	.5	532.1
D.	25% PMF Overtopping (2 Hour Breach)	547.1	.5	527.3

*Several houses located about 750 feet downstream of Ebenezers Dam.

Condition C: (Time refers to elapsed time after start of storm).
Time to reach breach elevation 547.1 at dam = 42.25 Hours.
Water level 500' downstream at 42.25 Hours = 524.7.
Duration of breach = 15 Minutes.
Time for Breach to peak 500' downstream = .25 Hours.
Peak elevation 500' downstream due to breach = 532.1.
Rate of increase in water level = 7.4' in 15 Minutes.

OVERTOPPING ANALYSIS 1/4

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
 LAST MODIFICATION 26 FEB 79
**********
```

```
     1  A1   EBENEZER DAM  ####  CLARK RUN
     2  A2   NORTH LEBANON TWP., LEBANON COUNTY, PA.
     3  A3   ND1 # PA-00599    PA DER # 38-8
     4  B  300    0   15    0    0    0    0    0   -4    0
     5  B1   5
     6  J    1    9    1
     7  J1   1   .8  .65   .5  .35  .25  .15   .1  .05
     8  K        1                          1
     9  K1            INFLOW HYDROGRAPH
    10  M    1    1   .5
    11  P        23.2  113  123  132  143
    12  T                                  1   .05
    13  W  2.09  .85
    14  X  -1.5 -.05    2
    15  K    1    2                        1
    16  K1            RESERVOIR ROUTING
    17  Y                      1
    18  Y1   1                                122   -1
    19  Y4 543  544.3  545  545.8  546.4  546.7  547  547.2  547.5  547.6
    20  Y4 547.8  548  548.3
    21  Y5   0   47  100  150  200  230  298  395  615  708
    22  Y5 930 1190 1630
    23  $A   0 10.1 33.4
    24  $E 506.5  543  560
    25  $$ 543
    26  $D 546.6
    27  K   99
```

```
1          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                    RUNOFF HYDROGRAPH AT        1
                    ROUTE HYDROGRAPH TO         2
                    END OF NETWORK
```

```
1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION  JULY 1978
 LAST MODIFICATION 26 FEB 79
**********

RUN  DATE# 79/04/12.
     TIME# 08.39.45.
```

EBENEZER DAM #### CLARK RUN
NORTH LEBANON TWP., LEBANON COUNTY, PA.
ND1 # PA-00599 PA DER # 38-8

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED

EBENEZER DAM **** CLARK RUN
NORTH LEBANON TWP., LEBANON COUNTY, PA.
NDI # PA-00599 PA DER # 38-8

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .80 .65 .50 .35 .25 .15 .10 .05

********** ********** ********** ********** **********

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.50	0.00	.50	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.09 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 19 END-OF-PERIOD ORDINATES, LAG= 2.07 HOURS, CP= .80 VOL= 1.00

8.	28.	50.	70.	88.	103.	117.	126.	127.	123.
114.	102.	86.	63.	38.	21.	12.	7.	4.	

0 END-OF-PERIOD FLOW

NO.	DA	HR.	MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.	DA	HR.	MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
													SUM	26.54	24.13	2.41	31476.
														(674.)	(613.)	(61.)	(891.30)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	122.	-1

STAGE	543.00	544.30	545.00	545.80	546.40	546.70	547.00	547.20	547.50
	547.80	548.00	548.30						
FLOW	0.00	47.00	100.00	150.00	200.00	230.00	298.00	395.00	615.00
	930.00	1190.00	1630.00						
SURFACE AREA=	0.	10.	33.						
CAPACITY=	0.	123.	473.						
ELEVATION=	507.	543.	560.						

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
543.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
546.6	0.0	0.0	0.

PEAK OUTFLOW IS 1562. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1250. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1015. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 779. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 538. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 350. AT TIME 42.50 HOURS

PEAK OUTFLOW IS 169. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 112. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 46. AT TIME 43.25 HOURS

1 ********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS								
				RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO
				1.00	.80	.65	.50	.35	.25	.15	.10	.(
HYDROGRAPH AT	1	.50	1	1564.	1251.	1017.	782.	548.	391.	235.	156.	7
		(1.29)		(44.30)(	35.44)(	28.79)(	22.15)(	15.50)(	11.07)(	6.64)(	4.43)(	2.2
ROUTED TO	2	.50	1	1562.	1250.	1015.	779.	538.	350.	169.	112.	4
		(1.29)		(44.24)(	35.39)(	28.73)(	22.06)(	15.24)(	9.92)(	4.79)(	3.16)(	1.3

1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	542.74	543.00	546.60
STORAGE	120.	123.	166.
OUTFLOW	0.	0.	220.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	548.25	1.65	191.	1562.	6.75	41.75	0.00
.80	548.04	1.44	187.	1250.	6.25	41.75	0.00
.65	547.87	1.27	184.	1015.	5.75	41.75	0.00
.50	547.66	1.06	181.	779.	5.00	41.75	0.00
.35	547.40	.80	177.	538.	3.75	42.00	0.00
.25	547.11	.51	173.	350.	2.50	42.50	0.00
.15	546.03	0.00	158.	169.	0.00	43.00	0.00
.10	545.19	0.00	147.	112.	0.00	43.00	0.00
.05	544.27	0.00	137.	46.	0.00	43.25	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****
EOI ENCOUNTERED.
N>

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                                                                                                                                    FLOOD HYDROGRAPH PACKAGE (HEC-1)
                                                                                                                                    DAM SAFETY VERSION     JULY 1978
                                                                                                                                      LAST MODIFICATION  26 FEB 79
                                                                                                                                    ************************************
     1     A1      EBENEZER DAM  ####  CLARK RUN
     2     A2      NORTH LEBANON TWP., LEBANON COUNTY, PA.
     3     A3      NDI #  PA-00599     PA DER #  38-8
     4     B  300      0     15      0      0      0      0      0     -4      0
     5     B1   5
     6     J    4      1      1
     7     J1  .25
     8     K            1                                                  1
     9     K1                INFLOW  HYDROGRAPH
    10     M    1      1     .5                                                        1
    11     P          23.2    113    123    132    143
    12     T                                                              1     .05
    13     W  2.09    .85
    14     X  -1.5   -.05      2
    15     K    1      2                                                  1
    16     K1                RESERVOIR  ROUTING  -  DAM BREAK
    17     Y                                1      1
    18     Y1   1                                                      122    -1
    19     Y4  543   544.3    545   545.8  546.4  546.7    547   547.2  547.5  547.6
    20     Y4 547.8   548   548.3
    21     Y5    0    47     100    150    200    230    298    395    615    708
    22     Y5  930  1190    1630
    23     $A    0   10.1   33.4
    24     $E 506.5   543    560
    25     $$  543
    26     $D 546.6
    27     $B   50      1    528   .25    543   547.1
    28     $B   50      1    528    .5    543   547.1
    29     $B   50      1    528     1    543   547.1
    30     $B   50      1    528     2    543   547.1
    31     K    1      3                                                  1
    32     K1                REACH  2 - 3
    33     Y                                1      1
    34     Y1   1
    35     Y6  .05    .04    .05    520    560    500   .002
    36     Y7    0    560    400    540    500    522    504    520    507    520
    37     Y7  511    522    850    540   1150    560
    38     K    99
1                    PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                  RUNOFF HYDROGRAPH AT          1
                                  ROUTE HYDROGRAPH TO           2
                                  ROUTE HYDROGRAPH TO           3
                                  END OF NETWORK


1************************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
 ************************************

 RUN  DATE# 79/04/13.
      TIME# 06.13.27.
```

EBENEZER DAM #### CLARK RUN
NORTH LEBANON TWP., LEBANON COUNTY, PA.
NDI # PA-00599 PA DER # 38-8

D
2/6

JOB SPECIFICATION

NQ	NMR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 4 NRTIO= 1 LRTIO= 1

RTIOS= .25

########## ########## ########## ########## ##########

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUNG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.50	0.00	.50	0.00	0.000	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.09 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 19 END-OF-PERIOD ORDINATES, LAG= 2.07 HOURS, CP= .80 VOL= 1.00

8.	28.	50.	70.	88.	103.	117.	126.	127.	123.
114.	102.	86.	63.	38.	21.	12.	7.	4.	

0 END-OF-PERIOD FLOW

NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	NO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	31476.
										(674.)(	613.)(	61.)(	891.30)

########## ########## ########## ########## ##########

HYDROGRAPH ROUTING

HYDROGRAPH ROUTING

RESERVOIR ROUTING - DAM BREAK

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	122.	-1

STAGE	543.00	544.30	545.00	545.80	546.40	546.70	547.00	547.20	547.50	547.60
	547.80	548.00	548.30							
FLOW	0.00	47.00	100.00	150.00	200.00	230.00	298.00	395.00	615.00	708.00
	930.00	1190.00	1630.00							
SURFACE AREA=	0.	10.	33.							
CAPACITY=	0.	123.	473.							
ELEVATION=	507.	543.	560.							

CREL	SPWID	COQW	EXPW	ELEVL	COOL	CAREA	EXPL
543.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
546.6	0.0	0.0	0.

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	528.00	.25	543.00	547.10

BEGIN DAM FAILURE AT 42.25 HOURS

PEAK OUTFLOW IS 7404. AT TIME 42.50 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	528.00	.50	543.00	547.10

BEGIN DAM FAILURE AT 42.25 HOURS

PEAK OUTFLOW IS 4219. AT TIME 42.64 HOURS

DAM BREACH DATA

BRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	528.00	1.00	543.00	547.10

BEGIN DAM FAILURE AT 42.25 HOURS

PEAK OUTFLOW IS 2406. AT TIME 42.83 HOURS

DRWID	Z	ELBM	TFAIL	WSEL	FAILEL
50.	1.00	528.00	2.00	543.00	547.10

B
4/6

BEGIN DAM FAILURE AT 42.25 HOURS

F OUTFLOW IS 1383. AT TIME 43.00 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ALL PLANS HAVE SAME ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0500	.0400	.0500	520.0	560.0	500.	.00200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 560.00 400.00 540.00 500.00 522.00 504.00 520.00 507.00 520.00
511.00 522.00 850.00 540.00 1150.00 560.00

STORAGE	0.00	.18	1.12	3.31	6.74	11.41	17.32	24.48	32.87	42.50
	53.44	66.10	80.53	96.75	114.75	134.52	156.08	179.42	204.54	231.44
OUTFLOW	0.00	29.62	223.46	809.16	1973.75	3874.85	6654.02	10441.95	15361.21	21528.01
	28756.68	37495.15	48164.75	60854.14	75688.59	92803.86	112337.69	134426.69	159205.21	186804.98
STAGE	520.00	522.11	524.21	526.32	528.42	530.53	532.63	534.74	536.84	538.95
	541.05	543.16	545.26	547.37	549.47	551.58	553.68	555.79	557.89	560.00
FLOW	0.00	29.62	223.46	809.16	1973.75	3874.85	6654.02	10441.95	15361.21	21528.01
	28756.68	37495.15	48164.75	60854.14	75688.59	92803.86	112337.69	134426.69	159205.21	186304.98

MAXIMUM STAGE IS 532.1

MA STAGE IS 530.8

MAXIMUM STAGE IS 528.9

MAXIMUM STAGE IS 527.3

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS

FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)

AREA IN SQUARE MILES (SQUARE KILOMETERS)

B

5/6

OPERATION	STATION	AREA	PLAN	RATIO 1
				.25
HYDROGRAPH AT	1	.50	1	391.
		(1.29)		(11.07)(
			2	391.
				(11.07)(
			3	391.
				(11.07)(
			4	391.
				(11.07)(
ROUTED TO	2	.50	1	7404.
		(1.29)		(209.65)(
			2	3877.
				(109.79)(
			3	2361.
				(66.86)(
			4	1383.
				(39.17)(
ROUTED TO	3	.50	1	6015.
		(1.29)		(170.32)(
			2	4245.
				(120.21)(
			3	2383.
				(67.47)(
			4	1368.
				(38.74)(

1

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	543.00	543.00	546.60
STORAGE	123.	123.	166.
OUTFLOW	0.	0.	220.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	547.11	.51	173.	7404.	1.08	42.50	42.25

PLAN 2 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	543.00	543.00	546.60
STORAGE	123.	123.	166.
OUTFLOW	0.	0.	220.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	547.11	.51	173.	4219.	1.12	42.64	42.25

6/6

PLAN 3 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	543.00	543.00	546.60
STORAGE	123.	123.	166.
OUTFLOW	0.	0.	220.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	547.11	.51	173.	2406.	1.19	42.83	42.25

PLAN 4 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	543.00	543.00	546.60
STORAGE	123.	123.	166.
OUTFLOW	0.	0.	220.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	547.11	.51	173.	1383.	1.25	43.00	42.25

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	6015.	532.1	42.50

PLAN 2 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	4245.	530.8	42.75

PLAN 3 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	2383.	528.9	42.75

PLAN 4 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	1260	527.7	43.00

PRIOR TO BREACH 1/5

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FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
 LAST MODIFICATION  26 FEB 79
**********************************
  1            A1     EBENEZER DAM  ****  CLARK RUN
  2            A2     NORTH LEBANON TWP., LEBANON COUNTY, PA.
  3            A3     NDI #  PA-00599     PA DER #  38-8
  4            B   300      0     15      0      0      0      0      0     -4      0
  5            B1    5
  6            J     1      1      1
  7            J1  .25
  8            K             1                                   1
  9            K1                  INFLOW  HYDROGRAPH
 10            M     1      1     .5
 11            P           23.2    113    123    132    143
 12            T                                                1     .05
 13            W  2.09     .85
 14            X  -1.5    -.05      2
 15            K     1      2                                   1
 16            K1                  RESERVOIR  ROUTING
 17            Y                                 1
 18            Y1    1                                        122     -1
 19            Y4  543   544.3    545   545.8  546.4  546.7    547   547.2   547.5   547.6
 20            Y4 547.8    548   548.3
 21            Y5    0     47    100    150    200    230    298    395     615     708
 22            Y5  930   1190   1630
 23            $A    0   10.1   33.4
 24            $E 506.5    543    560
 25            $$  543
 26            $D 546.6
 27            K     1      3                                   1
 28            K1                  REACH  2 - 3
 29            Y                                 1
 30            Y1    1
 31            Y6  .05    .04    .05    520    560    500   .002
 32            Y7    0    560    400    540    500    522    504    520     507     520
 33            Y7  511    522    850    540   1150    560
 34            K    99
1                          PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                   RUNOFF HYDROGRAPH AT          1
                                   ROUTE HYDROGRAPH TO           2
                                   ROUTE HYDROGRAPH TO           3
                                   END OF NETWORK

1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
 **********************************

 RUN  DATE# 79/04/12.
      TIME# 13.42.02.


                                   EBENEZER DAM  ****  CLARK RUN
                                   NORTH LEBANON TWP., LEBANON COUNTY, PA.
                                   NDI #  PA-00599     PA DER #  38-8
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EBENEZER DAM #### CLARK RUN
NORTH LEBANON TWP., LEBANON COUNTY, PA.
NDI # PA-00599 PA DER # 38-8

OB
2/5

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 1 LRTIO= 1
RTIOS= .25

########## ########## ########## ########## ##########

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.50	0.00	.50	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.09 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 19 END-OF-PERIOD ORDINATES, LAG= 2.07 HOURS, CP= .80 VOL= 1.00

8.	28.	50.	70.	88.	103.	117.	126.	127.	123.
114.	102.	86.	63.	38.	21.	12.	7.	4.	

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	31476.
										(674.)	(613.)	(61.)	(891.30)

########## ########## ########## ########## ##########

HYDROGRAPH ROUTING

UNIT HYDROGRAPH DATA
TP= 2.09 CP= .85 NTA= 0

OB
3/5

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 19 END-OF-PERIOD ORDINATES, LAG= 2.07 HOURS, CP= .80 VOL= 1.00

8.	28.	50.	70.	88.	103.	117.	126.	127.	123.
114.	102.	86.	63.	38.	21.	12.	7.	4.	

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	31476.
										(674.)	(613.)	(61.)	(891.30)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	122.	-1

STAGE	543.00	544.30	545.00	545.80	546.40	546.70	547.00	547.20	547.50	547.60
	547.80	548.00	548.30							
FLOW	0.00	47.00	100.00	150.00	200.00	230.00	298.00	395.00	615.00	708.00
	930.00	1190.00	1630.00							
SURFACE AREA=	0.	10.	33.							
CAPACITY=	0.	123.	473.							
ELEVATION=	507.	543.	560.							

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
543.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
546.6	0.0	0.0	0.

PEAK OUTFLOW IS 350. AT TIME 42.50 HOURS

********** ********** ********** ********** **********

TOPEL	COQD	EXPD	DAMWID
546.6	0.0	0.0	0.

OB
4/5

PEAK OUTFLOW IS 350. AT TIME 42.50 HOURS

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

REACH 2 - 3

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
3	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	0.	0

NORMAL DEPTH CHANNEL ROUTING

QN(1)	QN(2)	QN(3)	ELNVT	ELMAX	RLNTH	SEL
.0500	.0400	.0500	520.0	560.0	500.	.00200

CROSS SECTION COORDINATES--STA,ELEV,STA,ELEV--ETC

0.00 560.00 400.00 540.00 500.00 522.00 504.00 520.00 507.00 520.00
511.00 522.00 850.00 540.00 1150.00 560.00

STORAGE	0.00	.18	1.12	3.31	6.74	11.41	17.32	24.48	32.87	42.50
	53.44	66.10	80.53	96.75	114.75	134.52	156.08	179.42	204.54	231.44
OUTFLOW	0.00	29.62	223.46	809.16	1973.75	3874.85	6654.02	10441.95	15361.21	21528.01
	28756.68	37495.15	48164.75	60854.14	75688.59	92803.86	112337.69	134426.69	159205.21	186804.98
STAGE	520.00	522.11	524.21	526.32	528.42	530.53	532.63	534.74	536.84	538.95
	541.05	543.16	545.26	547.37	549.47	551.58	553.68	555.79	557.89	560.00
FLOW	0.00	29.62	223.46	809.16	1973.75	3874.85	6654.02	10441.95	15361.21	21528.01
	28756.68	37495.15	48164.75	60854.14	75688.59	92803.86	112337.69	134426.69	159205.21	186804.98

MAXIMUM STAGE IS 524.7

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIO 1 RATIOS APPLIED TO FLOWS .25
HYDROGRAPH AT	1	.50	1	391.
		(1.29)		(11.07)(
ROUTED TO	2	.50	1	350.
		(1.29)		(9.92)(
ROUTED TO	3	.50	1	352.
		(1.29)		(9.96)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	542.74	543.00	546.60
STORAGE	120.	123.	166.
OUTFLOW	0.	0.	220.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.25	547.11	.51	173.	350.	2.50	42.50	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.25	352.	524.7	42.50

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****
EOI ENCOUNTERED.
N>

OVERTOPPING ANALYSIS
IMPROVED EMBANKMENT
1/4

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1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
**********************************
    1              A1     EBENEZER DAM   ****   CLARK RUN
    2              A2     NORTH LEBANON TWP., LEBANON COUNTY, PA.
    3              A3     NDI #  PA-00599     PA DER #  38-8
    4              B   300      0     15      0      0      0      0      0     -4      0
    5              B1    5
    6              J     1      9      1
    7              J1    1     .8    .65     .5    .35    .25    .15    .1    .05
    8              K                  1                                  1
    9              K1                      INFLOW  HYDROGRAPH
   10              M     1      1     .5
   11              P           23.2    113    123    132    143
   12              Y                                                    1     .05
   13              W  2.09     .85
   14              X  -1.5    -.05      2
   15              K     1      2                                       1
   16              K1                     RESERVOIR  ROUTING
   17              Y                                 1
   18              Y1    1                                            122
   19              $A    0    10.1    33.4
   20              $E 506.5     543     560
   21              $$    543     12    2.67    1.5
   22              $D 547.6     2.7     1.5    329
   23              K     99
1                        PREVIEW OF SEQUENCE OF STREAM NETWORK CALCULATIONS

                                 RUNOFF HYDROGRAPH AT          1
                                 ROUTE HYDROGRAPH TO           2
                                 END OF NETWORK

1**********************************
 FLOOD HYDROGRAPH PACKAGE (HEC-1)
 DAM SAFETY VERSION     JULY 1978
   LAST MODIFICATION  26 FEB 79
**********************************

 RUN  DATE# 79/04/13.
      TIME# 06.39.11.


                          EBENEZER DAM   ****   CLARK RUN
                          NORTH LEBANON TWP., LEBANON COUNTY, PA.
                          NDI #  PA-00599     PA DER #  38-8

                                        JOB SPECIFICATION
                          NO     NHR    NMIN    IDAY     IHR    IMIN   METRC    IPLT    IPRT   NSTAN
                          300      0      15       0       0       0       0       0      -4       0
                                        JOPER     NWT   LROPT   TRACE
                                            5       0       0       0


                                   MULTI-PLAN ANALYSES TO BE PERFORMED
                                                NPLAN= 1 NRTIO= 9 LRTIO= 1
                          RTIOS=  1.00    .80    .65    .50    .35    .25    .15    .10    .05
```

EBENEZER DAM #### CLARK RUN
NORTH LEBANON TWP., LEBANON COUNTY, PA.
ND1 # PA-00599 PA DER # 38-8

2/4

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
300	0	15	0	0	0	0	0	-4	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 9 LRTIO= 1
RTIOS= 1.00 .80 .65 .50 .35 .25 .15 .10 .05

########## ########## ########## ########## ##########

SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICONP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	1	.50	0.00	.50	0.00	0.000	0	0	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	23.20	113.00	123.00	132.00	143.00	0.00	0.00

TRSPC COMPUTED BY THE PROGRAM IS .800

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	1.00	.05	0.00	0.00

UNIT HYDROGRAPH DATA
TP= 2.09 CP= .85 NTA= 0

RECESSION DATA
STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.00

UNIT HYDROGRAPH 19 END-OF-PERIOD ORDINATES, LAG= 2.07 HOURS, CP= .80 VOL= 1.00

8.	28.	50.	70.	88.	103.	117.	126.	127.	123.
114.	102.	86.	63.	38.	21.	12.	7.	4.	

0 END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
									SUM	26.54	24.13	2.41	31476.
										(674.)	(613.)	(61.)	(891.30

########## ########## ########## ########## ##########

HYDROGRAPH ROUTING

********** ********** ********** ********** ********** I

3/4

HYDROGRAPH ROUTING

RESERVOIR ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	0	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	122.	0

SURFACE AREA=	0.	10.	33.
CAPACITY=	0.	123.	473.
ELEVATION=	507.	543.	560.

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
543.0	12.0	2.7	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
547.6	2.7	1.5	329.

PEAK OUTFLOW IS 1562. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1249. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 1014. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 779. AT TIME 41.75 HOURS

PEAK OUTFLOW IS 531. AT TIME 42.00 HOURS

PEAK OUTFLOW IS 299. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 173. AT TIME 42.75 HOURS

PEAK OUTFLOW IS 111. AT TIME 43.00 HOURS

PEAK OUTFLOW IS 50. AT TIME 43.00 HOURS

1 ********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7	RATIO 8	RATIO 9
				1.00	.80	.65	.50	.35	.25	.15	.10	.05
HYDROGRAPH AT	1	.50	1	1564.	1251.	1017.	782.	548.	391.	235.	156.	78.
		(1.29)		(44.30)(	35.44)(	28.79)(	22.15)(	15.50)(	11.07)(	6.64)(	4.43)(	2.21)
ROUTED TO	2	.50	1	1562.	1249.	1014.	779.	531.	299.	173.	111.	50.
		(1.29)		(44.24)(	35.37)(	28.71)(	22.05)(	15.03)(	8.48)(	4.90)(	3.14)(	1.41)

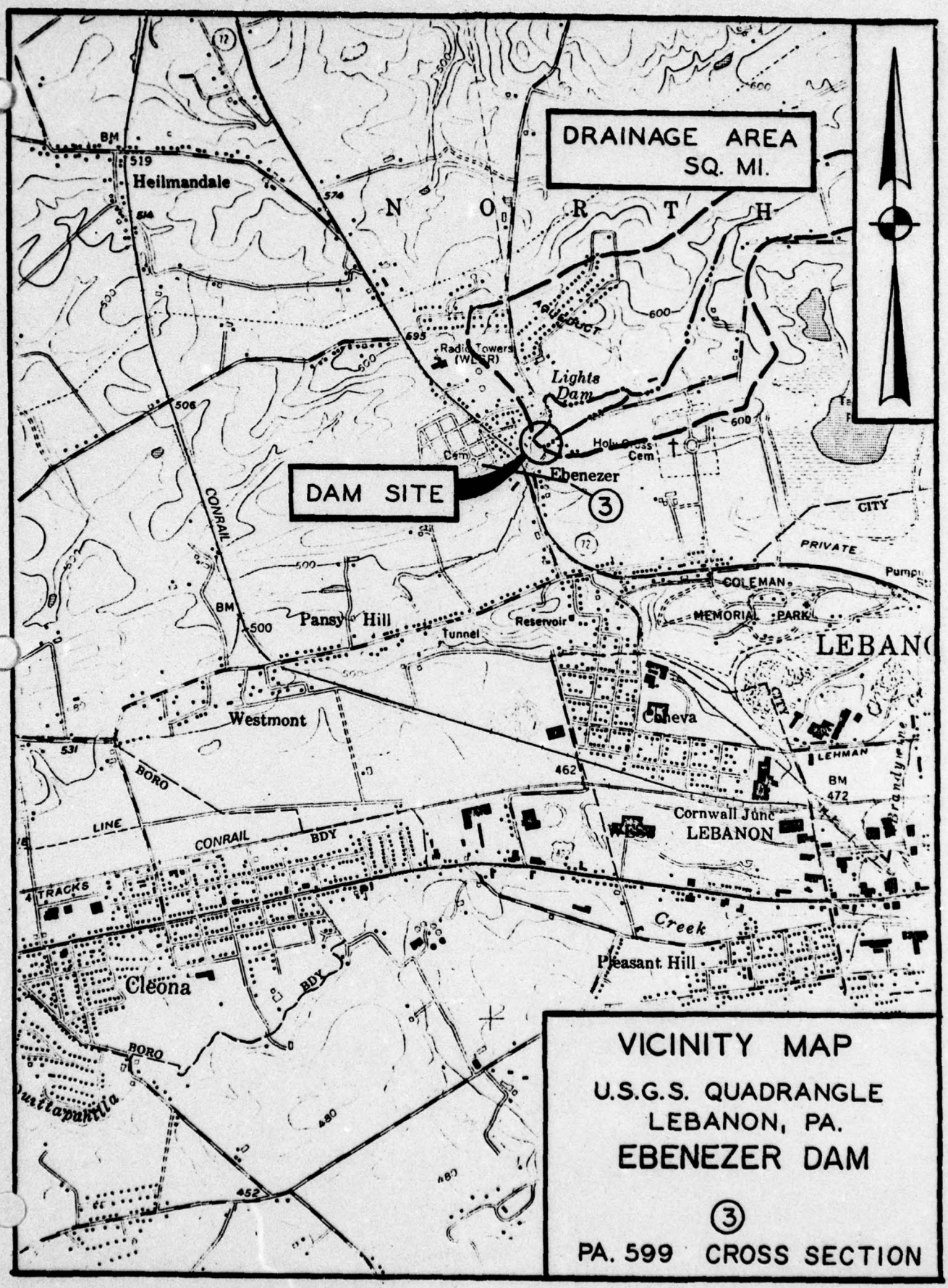
1 SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	542.74	543.00	547.60
STORAGE	120.	123.	180.
OUTFLOW	0.	0.	316.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	548.77	1.17	199.	1562.	5.75	41.75	0.00
.80	548.56	.96	195.	1249.	5.25	41.75	0.00
.65	548.38	.78	193.	1014.	4.50	41.75	0.00
.50	548.19	.59	189.	779.	3.75	41.75	0.00
.35	547.94	.34	186.	531.	2.25	42.00	0.00
.25	547.44	0.00	178.	299.	0.00	42.75	0.00
.15	546.08	0.00	159.	173.	0.00	42.75	0.00
.10	545.29	0.00	149.	111.	0.00	43.00	0.00
.05	544.34	0.00	137.	50.	0.00	43.00	0.00

1**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****
EOI ENCOUNTERED.
N>


DRAINAGE AREA
SQ. MI.
N O R T H
DAM SITE
Heilmandale
Lights Dam
Ebenezer
3
CONRAIL
Pansy Hill
Tunnel
Reservoir
COLEMAN
MEMORIAL PARK
CITY
PRIVATE
Westmont
Cleona
Cornwall Junc
LEBANON
LEHMAN
Pleasant Hill
Creek
BORO
LINE
CONRAIL
BDY
4 TRACKS
BM
519
500
462
472
531
452
480
VICINITY MAP
U.S.G.S. QUADRANGLE
LEBANON, PA.
EBENEZER DAM
3
PA. 599 CROSS SECTION

APPENDIX D

GEOLOGIC REPORT

GEOLOGIC REPORT

Bedrock - Dam and Reservoir

Formation Name: Martinsburg Formation.

Lithology: The dam and reservoir are located in the gray shale facies of the Martinsburg Formation; which consists of medium gray to dark gray shale which weathers light gray to buff. Interbeds of silty shale and limy shale also are present.

Structure

The Martinsburg shale in this area has had a long and complex structural history, the details of which are still the subject of scientific debate. The beds in this area are tightly folded and faulted. Cleavage often obscures the original bedding. At the dam the beds strike about E-W and dip 36° south. The strike of the beds is nearly at right angles to the dam. No faults have been mapped close to the dam, but exposures are few and detailed mapping is not possible.

Air Photo Fracture traces trend N-S, N15°E, N30°E.

Overburden

No core boring information is available for this dam, which was originally built in 1820. The overburden in this area consists of weathered shale, which is commonly 10 to 30 feet thick. Alluvium in the valleys of small creeks generally consists of silt and clay with minor sand and gravel.

Aquifer Characteristics

The Martinsburg shale is an essentially impermeable rock and ground water movement is along secondary fractures, joints and cleavage. The upper weathered zone is usually quite permeable, and in the unweathered shale major fracture zones can also be quite permeable.

Discussion

This dam has a long history of leakage. It is one of the dams built about 1820 to supply water to the Union Canal. There are no plans available, but apparently most or all of these dams were built without any kind of a cutoff trench. The inspection report of 1915 reported leakage and weirs were requested. Leakage continues along the toe, but apparently has not increased.

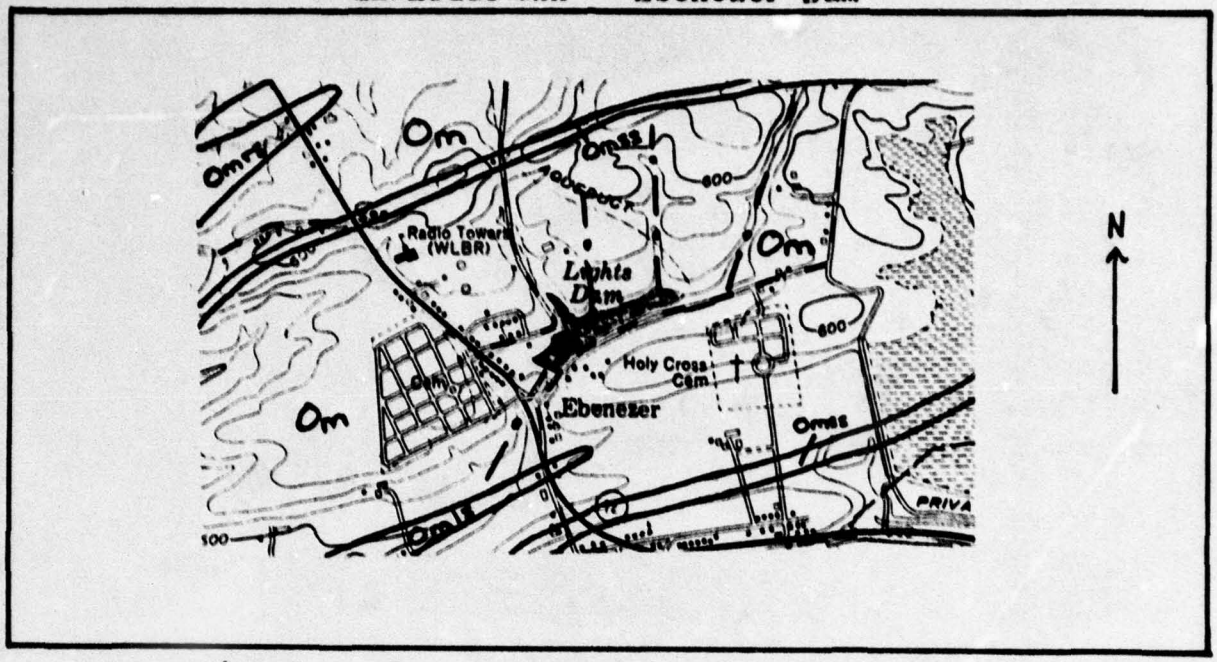
Sources of Information

1. Geyer, A.R., Gray, C., et al. (1958), "Geology of the Lebanon Quadrangle". Pa. Geological Survey. Atlas 167c.

2. Air Photos, scale 1:24,000. Dated 1969.

3. Inspection reports in file.

GEOLOGIC MAP - Ebenezer Dam



(geology from Pa. Geol. Surv. Atlas 167C)

Om	Martinsburg Fm.- shale
Omss	Martinsburg Fm.- sandstone
Omrs	Martinsburg Fm.- red shale
Oml s	Martinsburg Fm.- limestone

—·—·— air photo fracture trace

SCALE 1:24000

1 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

1 .5 0 1 KILOMETER

CONTOUR INTERVAL 20 FEET

APPENDIX E

PHOTOGRAPHS

Upstream Slope
and
Old Gate Structure

Downstream Slope

Conduit Outlet

PA-00599
PLATE E-1

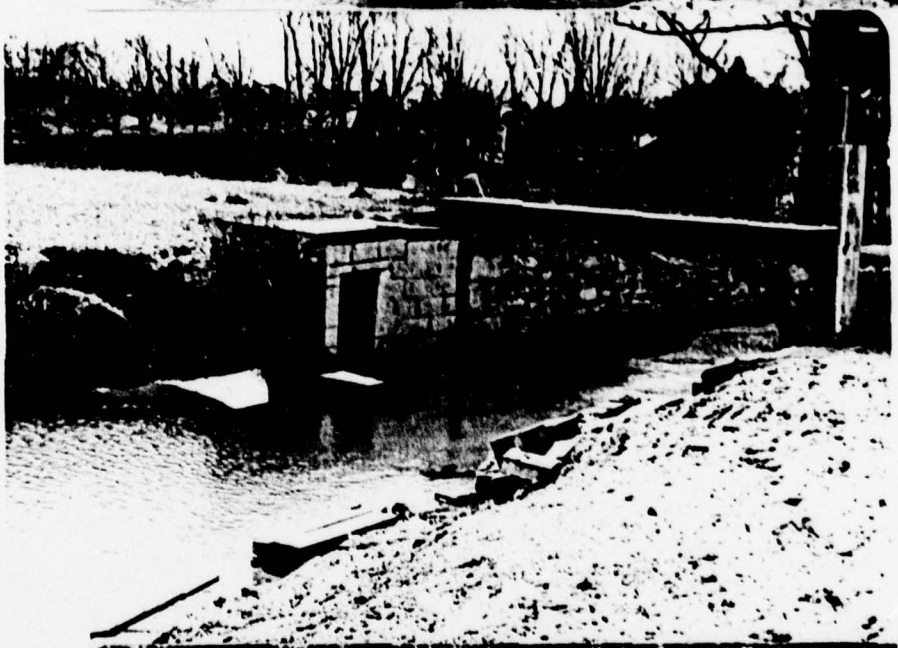
Saturated
Downstream Slope

Downstream Toe

Slough on
Downstream Slope

PA-00599
PLATE E-II

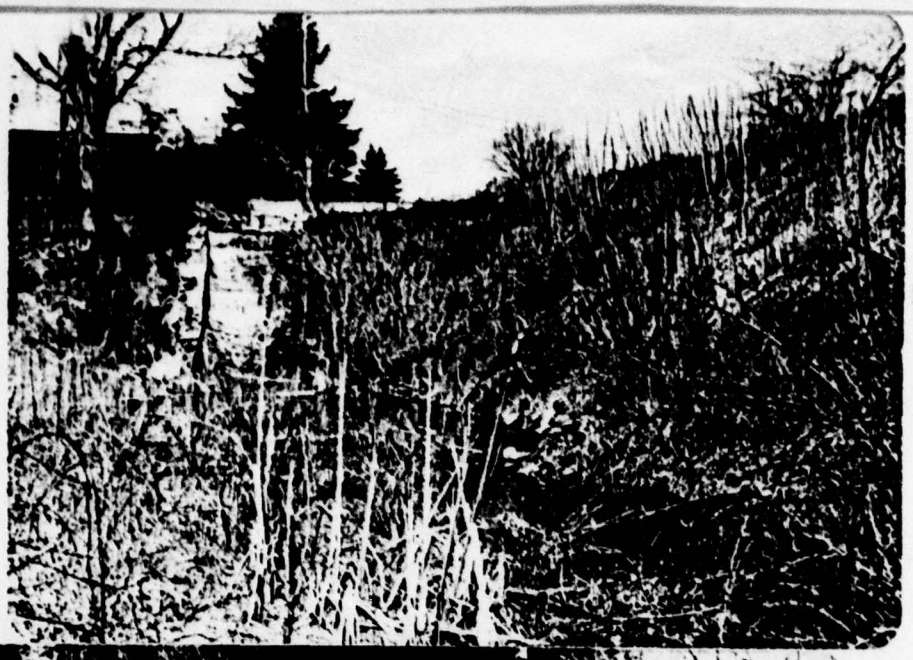
"Duck House" at Spillway Bridge



Forebay

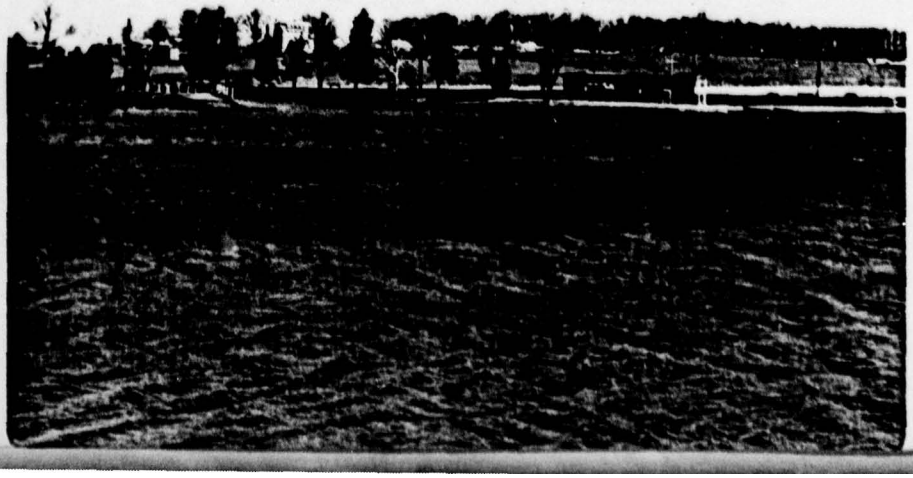
Top of Spillway Chute

PA-00599
plate E-III



Spillway and
Downstream Channel

Deteriorated Right
Spillway Wall

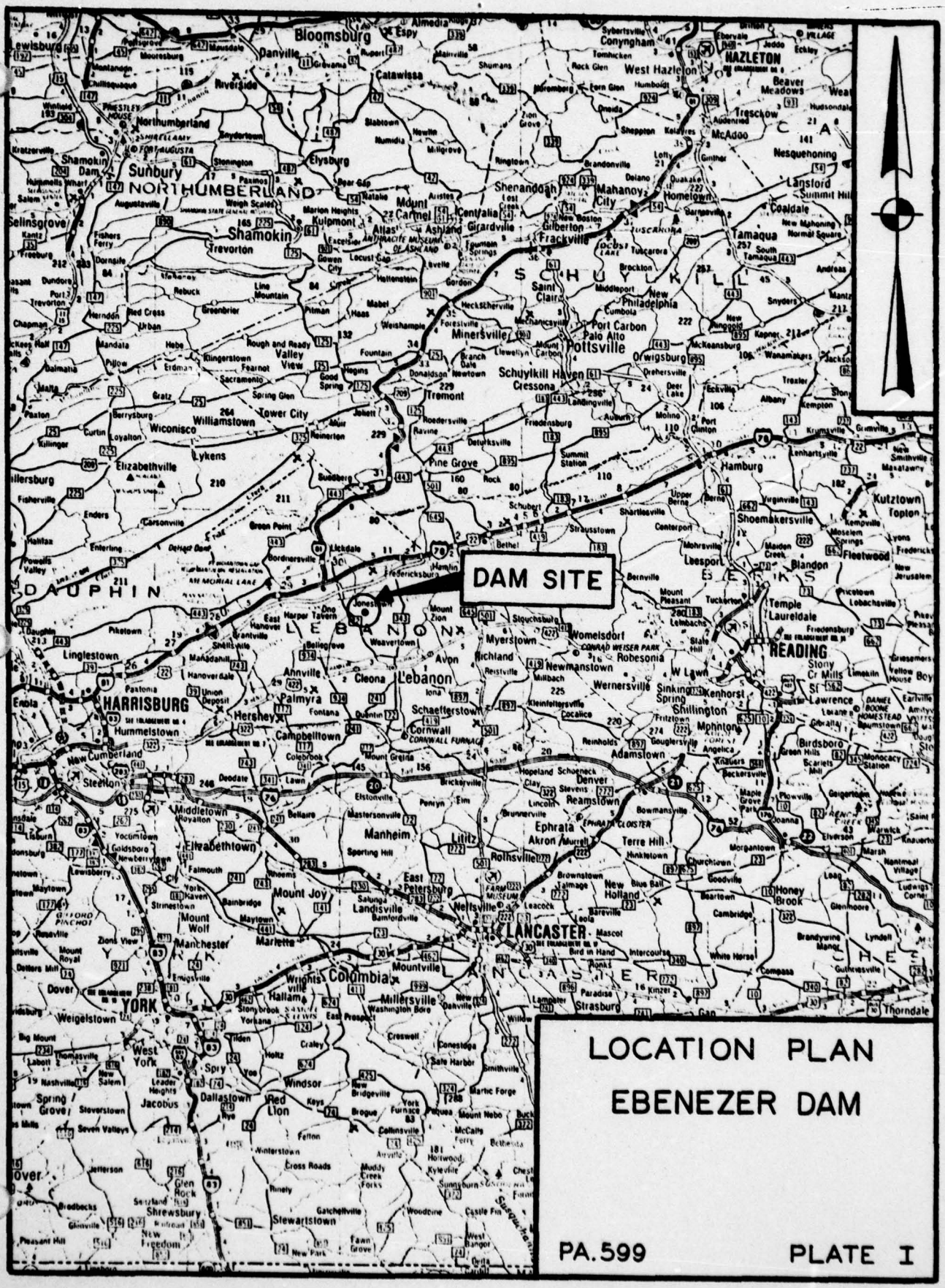


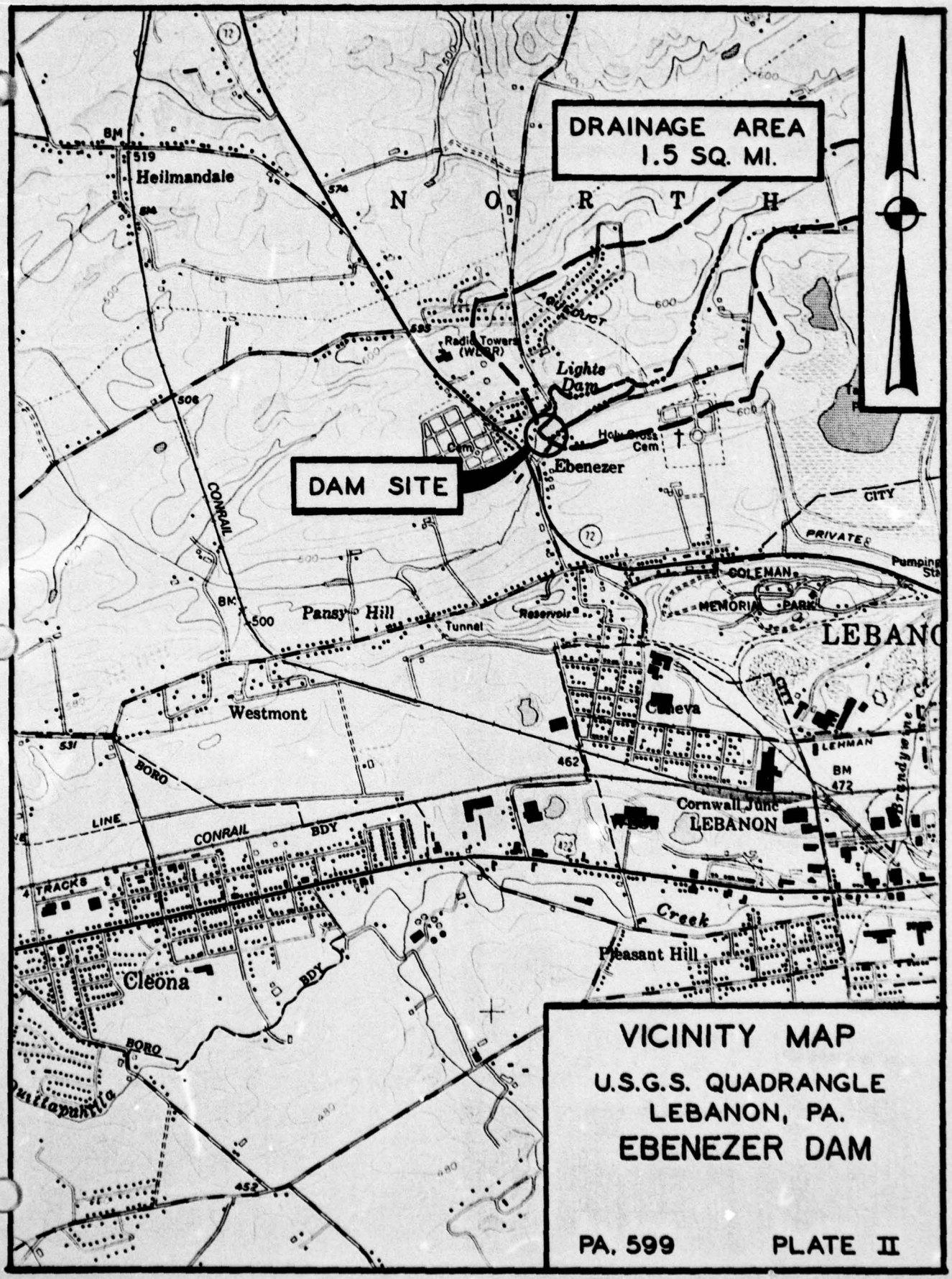
Reservoir With
Public Beach House

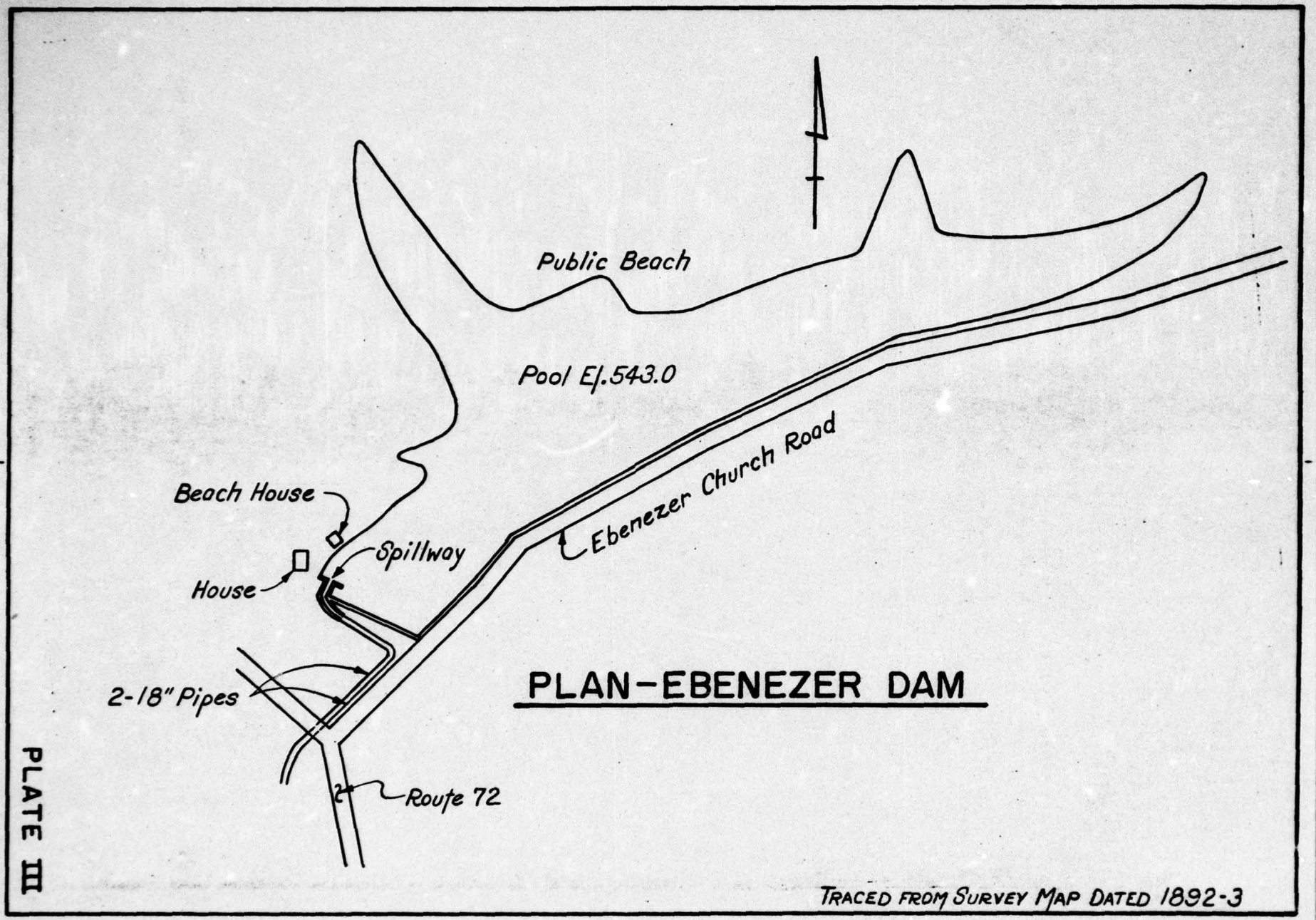
PA-00599
PLATE E-IV

APPENDIX F

PLATES


DAM SITE
LOCATION PLAN
EBENEZER DAM
PA. 599
PLATE I


DRAINAGE AREA
1.5 SQ. MI.
N O R T H
DAM SITE
Heilmandale
519
574
Radio Towers
(WLBR)
Lights
Dam
Ebenezer
Cem
Holy Cross
Cem
CITY
PRIVATE
Pumping
Sta
COLEMAN
MEMORIAL
PARK
LEBANO
Reservoir
Tunnel
Pansy Hill
500
CONRAIL
Westmont
Cleona
531
BORO
LINE
CONRAIL
BDY
462
LEHMAN
BM
472
Cornwall Junc
LEBANON
4 TRACKS
BDY
Creek
Pleasant Hill
BORO
Quittapahilla
452
VICINITY MAP
U.S.G.S. QUADRANGLE
LEBANON, PA.
EBENEZER DAM
PA. 599
PLATE II



PLAN-EBENEZER DAM

PLATE III

TRACED FROM SURVEY MAP DATED 1892-3